

DIVISION 00– PROCEDURAL & CONTRACTING REQUIREMENTS

SECTION 003123
GEOTECHNICAL DATA

1.1 SUMMARY

- A. Soils tests have been conducted at the site of this project by:

TSC Testing Service Corporation
2235 23th Avenue
Rockford, IL 61104-7334
Tel: (815) 394-2562; Fax: (815) 394-2566

- B. This enclosed investigation of soil compositions was prepared for the Owner. A copy of TSC's report, titled "Report of Soils Exploration, Proposed Cafeteria Building Addition, Lewis Lemon Elementary School, 1993 Mulberry Street, Rockford, IL, dated November 20, 2015, TSC No. L-83,579 and consisting of:

1. 13 pages of information.
2. 2 pages of Important Information About Your Geotechnical Engineering Report
3. 1 page titled General Conditions Geotechnical and Construction Services
4. Appendix consisting of Unified Classification Chart, Legend for Boring Logs, Boring Logs and Boring Location Plan.

- C. The Owner does not represent that the findings are a warrant of subsurface conditions.

1.2 ADDITIONAL INFORMATION

- A. Prospective contractors shall visit the site and acquaint themselves with all existing conditions. Bidders may, at no cost to Owner, make their own additional subsurface investigations as they may deem necessary for accurate bidding. Any such investigations; however, must be coordinated with Owner for times and means of access to the site

END OF DOCUMENT 003123

DIVISION 01 – GENERAL REQUIREMENTS

SECTION 011000
SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Access to site.
- 4. Coordination with occupants.
- 5. Work restrictions.
- 6. Specification and drawing conventions.
- 7. Miscellaneous provisions.

B. Related Requirements:

- 1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: Cafeteria Addition and Remodeling Project to Lewis Lemon Elementary School, 1993 Mulberry Street, Rockford, Illinois 61101 for Rockford Public School District #205.
- B. Owner: Board of Education of Rockford School District No. 205, Winnebago and Boone Counties, Illinois.
- C. Architect: Richard L Johnson Associates, Inc., 4703 Charles Street, Rockford, IL 61108.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of Cafeteria Addition and Remodeling Work.

- B. Contractor is responsible for construction means, methods and sequencing. Architect will not have control over, be in charge of, or be responsible for construction means, methods, techniques, sequences, procedures or safety precautions and programs in connection with the Work, as these are solely within the responsibility of the Contractor. Architect shall not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents.
- C. Type of Contract: Project will be constructed under a Single Contract to a General Contractor for all Work.

1.5 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
 - 1. Driveways, Walkways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

1.6 COORDINATION WITH OCCUPANTS

- A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 - 2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.7 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

- B. On-Site Work Hours: Normal business working hours will be 7:00 a.m. to 3:30 p.m., Monday through Friday, unless otherwise indicated or approved by the Owner.
- C. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Architect and Owner not less than two days in advance of proposed disruptive operations.
- D. Nonsmoking Building: Smoking is not permitted within the building or anywhere on the site.
- E. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
- F. Guns: Guns are prohibited on school grounds.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 - 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012300
ALTERNATES

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 alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section.

PART 2 - EXECUTION

2.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1:

1. All work associated with the West parking lot, including site and electrical work.

PART 3 - END OF SECTION 012300

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. Section includes administrative and procedural requirements for handling and processing Contract modifications.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue through Owner supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."

1.4 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. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request or 10 days, when not otherwise specified, 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 changed conditions require modifications to the Contract, Contractor may initiate a claim 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.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.
- B. The combined overhead and profit included in the total cost to the Owner for a change in the Work shall be based on the following schedule:
 - 1. For the Contractor, for Work performed by the Contractor's own forces, twelve percent of the cost.
 - 2. For the Contractor, for Work performed by the Subcontractor's, five percent of the amount due the Subcontractors.
 - 3. For each Subcontractor involved, for Work performed by the Subcontractor's own forces, five percent of the cost.
 - 4. For each Subcontractor involved, for Work performed by the Subcontractor's Sub-subcontractors, five percent of the amount due the Sub-subcontractor.
 - 5. In order to facilitate checking of quotations for extras and credits, all proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs including labor, materials and Subcontracts. Labor and materials shall be itemized in the manner prescribed above. Where major cost items are Subcontracts, they shall be itemized also.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Work Change Directive: Architect may issue a Construction Work Change Directive on AIA Document G714. Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
- 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.

END OF SECTION 012600

DIVISION 01 – GENERAL REQUIREMENTS

SECTION 012900
PAYMENT 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 necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.

1.3 DEFINITIONS

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

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Submittal schedule.
 - c. Items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
2. Arrange schedule of values consistent with format of AIA Document G703.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
6. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
7. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Times: Submit Application for Payment to Architect by the 10th of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

- D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect and/or Project Manager will return incomplete applications without action.
 - 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 - 2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect or Program Manager by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
 - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
 - 1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 - 2. When an application shows completion of an item, submit conditional final or full waivers.
 - 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 - 4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
 - 1. List of subcontractors.
 - 2. Schedule of values.
 - 3. Contractor's construction schedule (preliminary if not final).
 - 4. Submittal schedule (preliminary if not final).
 - 5. List of Contractor's staff assignments.
 - 6. List of Contractor's principal consultants.
 - 7. Initial progress report.
 - 8. Certificates of insurance and insurance policies.
 - 9. Performance and payment bonds.
- I. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
 - 1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

- J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706-1994, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A-1994, "Contractor's Affidavit of Release of Liens."
 6. AIA Document G707-1994, "Consent of Surety to Final Payment."
- K. The Owner will make payments once a month to the General Contractor as long as all required documentation is submitted.
- L. Retainage Reduction down to 5%:
1. Contractor may request a reduction in retainage to 5% for the following work completed by Substantial Completion dates listed herein:
 - a. Kitchen Remodeling: August 11, 2017.
 - b. Parking Lot: August 4, 2017.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100

PROJECT MANAGEMENT & 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.
- B. General Contractor shall have a full time foreman on site at all times any work is taking place to coordinate all work. The foreman shall remain the same throughout the entire project.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Coordination drawings.
 - 2. Requests for Information (RFIs).
 - 3. Project meetings.
- B. Related Requirements:
 - 1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.3 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. 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.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. 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 and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.

1.7 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. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing 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.
- C. RFI Forms: AIA Document G716.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. 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 adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

1.8 PROJECT MEETINGS

- A. General Contractor: 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 agreements achieved. 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.
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. Preparation of record documents.
 - m. Use of the premises and existing building.
 - n. Work restrictions.
 - o. Working hours.
 - p. Owner's occupancy requirements.
 - q. Responsibility for temporary facilities and controls.
 - r. Procedures for moisture and mold control.
 - s. Procedures for disruptions and shutdowns.
 - t. Construction waste management and recycling.
 - u. Parking availability.
 - v. Office, work, and storage areas.
 - w. Equipment deliveries and priorities.
 - x. First aid.
 - y. Security.
 - z. Progress cleaning.
 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Progress Meetings: General Contractor to conduct progress meetings at weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. 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.

3. 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) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
4. 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

DIVISION 01 – GENERAL REQUIREMENTS

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.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

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."

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 revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1.5 GENERAL COORDINATION PROCEDURES

- A. Online Submittal System: The Contractor will be required to provide an online "cloud" based collaborative, secure system for exchanging, reviewing and archiving construction submittals, RFI's and other construction communications electronically. Basis of Design: "Submittal Exchange" or Owner approved equivalent system.

1.6 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on 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 5 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.
- C. Paper Submittals: Place a permanent label or title block on each 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.
4. 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.
- a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return without review submittals received from sources other than Contractor.
- a. Transmittal Form for Paper Submittals: Use.
 - b. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
 - 1) Project name.
 - 2) Date.
 - 3) Destination (To:).
 - 4) Source (From:).
 - 5) Name and address of Architect.
 - 6) Name of Contractor.
 - 7) Name of firm or entity that prepared submittal.
 - 8) Names of subcontractor, manufacturer, and supplier.
 - 9) Category and type of submittal.
 - 10) Submittal purpose and description.
 - 11) Specification Section number and title.
 - 12) Specification paragraph number or drawing designation and generic name for each of multiple items.
 - 13) Drawing number and detail references, as appropriate.
 - 14) Indication of full or partial submittal.
 - 15) Transmittal number, numbered consecutively.
 - 16) Submittal and transmittal distribution record.
 - 17) Remarks.
 - 18) Signature of transmitter.

- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:

1. Summary:
 - a. Shop drawing and product data submittals shall be transmitted to Architect in electronic (PDF) format using Submittal Exchange, a website service designed specifically for transmitting submittals between construction team members.
 - b. The intent of electronic submittals is to expedite the construction process by reducing paperwork, improving information flow, and decreasing turnaround time.
 - c. The electronic submittal process is not intended for color samples, color charts, or physical material samples.
2. Procedures:
 - a. Submittal Preparation - Contractor may use any or all of the following options:
 - 1.) Subcontractors and Suppliers provide electronic (PDF) submittals to Contractor via the Submittal Exchange website.
 - 2.) Subcontractors and Suppliers provide paper submittals to General Contractor who electronically scans and converts to PDF format.
 - 3.) Subcontractors and Suppliers provide paper submittals to Scanning Service which electronically scans and converts to PDF format.
 - b. Contractor shall review and apply electronic stamp certifying that the submittal complies with the requirements of the Contract Documents including verification of manufacturer / product, dimensions and coordination of information with other parts of the work
 - c. Contractor shall transmit each submittal to Architect using the Submittal Exchange website, www.submittalexchange.com.
 - d. Architect / Engineer review comments will be made available on the Submittal Exchange website for downloading. Contractor will receive email notice of completed review.
 - e. Distribution of reviewed submittals to subcontractors and suppliers is the responsibility of the Contractor.

3. Other:

- 1.) The cost of Submittal Exchange is the responsibility of the Contractor.
- 2.) At Contractor's option, training is available from Submittal Exchange regarding use of website and PDF submittals. Contact Submittal Exchange at 1-800-714-0024.
- 3.) Internet Service and Equipment Requirements:
 - a.) Email address and Internet access at Contractor's main office.
 - b.) Adobe Acrobat (www.adobe.com), Bluebeam PDF Revu (www.bluebeam.com), or other similar PDF review software for applying electronic stamps and comments.

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. Submit Product Data before or concurrent with Samples.
5. Submit Product Data in the following format:
 - a. PDF electronic file.

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, unless submittal based on Architect's digital data drawing files is otherwise permitted.

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. PDF electronic file
 - b. .
- 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.
 - e. Specification paragraph number and generic name of each item.
 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. 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.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
 6. 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. Mark up and retain one returned Sample set as a project record sample.
 - 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. Submit product schedule in the following format:
 - a. PDF electronic file.
 - b. Three paper copies of product schedule or list unless otherwise indicated. Architect will return two copies.
- F. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- 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. 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.
- L. 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.
- M. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- N. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

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: See requirements in Section 017700 "Closeout Procedures."
- C. Contractor's Review Stamp: review each submittal with a uniform, review 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 review stamp and will return them without action.
- B. Action Submittals: Architect's review is performed to determine general conformance with the design concept set forth in the Contract Documents. Review does not relieve Contractor of sole responsibility for means, methods, sequencing, scheduling of work, verification of quantities and dimensions or the performance of the work in a safe manner. No comments on the shop drawings will relieve the Contractor from performing the work in a manner consistent with the Contract Documents. Architect's review will indicate action mark as follows:
 - 1. Reviewed.
 - 2. Note Comments.
 - 3. Rejected.
 - 4. Not reviewed/Outside scope of Services.
 - 5. Resubmit After Required General Contractor Review.
 - 6. Revise.
 - 7. Resubmit.
- C. Subcontractors are not to use shop drawings and submittals to ask questions or request information. All questions must be asked through the RFI.
- D. Architect is not responsible for correcting errors in the shop drawings or submittals.
- E. 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.
- F. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- G. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

DIVISION 01 – GENERAL REQUIREMENTS

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. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
 - 2. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

- A. 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.
- B. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. 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 in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- D. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five 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.

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 for a decision before proceeding.

1.5 INFORMATIONAL SUBMITTALS

- A. 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.

1.6 REPORTS AND DOCUMENTS

- A. Manufacturer's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 - 1. Name, address, and telephone number of technical representative making report.
 - 2. Statement on condition of substrates and their acceptability for installation of product.
 - 3. Statement that products at Project site comply with requirements.
 - 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 6. Statement whether conditions, products, and installation will affect warranty.
 - 7. Other required items indicated in individual Specification Sections.
- B. 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. **Manufacturer's 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.
- G. **Mockups:** Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect and Owner seven days in advance of dates and times when mockups will be constructed.
 - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed unless otherwise indicated.
- H. **Integrated Exterior Mockups:** Construct integrated exterior mockup 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. **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. 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.
 - b. Contractor must coordinate any testing with the Owner's testing service.
 - c. Owner will employ B&F Technical Code Services, Inc. www.bftechcs.com; PH: 847-428-7010; Fax 847-428-3151; 2420 Vantage Drive, Elgin, IL 60124 for testing services.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. 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."
- C. 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.
- D. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- E. 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.
- F. 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.

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 Architect.
 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 Architect'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. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- 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 014200
REFERENCES

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 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in the following list:
 - 1. AIA - American Institute of Architects (The); www.aia.org.
 - 2. AISC - American Institute of Steel Construction; www.aisc.org.
 - 3. AISI - American Iron and Steel Institute; www.steel.org.
 - 4. ANSI - American National Standards Institute; www.ansi.org.
 - 5. ASTM - ASTM International; www.astm.org.
 - 6. AWWA - American Wood Protection Association; www.awpa.com.
 - 7. CSI - Construction Specifications Institute (The); www.csinet.org.
 - 8. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
 - 9. DHI - Door and Hardware Institute; www.dhi.org.
 - 10. GANA - Glass Association of North America; www.glasswebsite.com.
 - 11. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
 - 12. ICBO - International Conference of Building Officials; (See ICC).
 - 13. ICC - International Code Council; www.iccsafe.org.
 - 14. MPI - Master Painters Institute; www.paintinfo.com.
 - 15. NFPA - National Fire Protection Association; www.nfpa.org.
 - 16. NFPA - NFPA International; (See NFPA).
 - 17. NFRC - National Fenestration Rating Council; www.nfrc.org.
 - 18. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
 - 19. SPIB - Southern Pine Inspection Bureau; www.spib.org.
 - 20. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
 - 21. UL - Underwriters Laboratories Inc.; www.ul.com.
 - 22. WDMA - Window & Door Manufacturers Association; www.wdma.com.
 - 23. WWPA - Western Wood Products Association; www.wwpa.org.

- B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
1. ICC - International Code Council; www.iccsafe.org.
 2. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.
 3. IBC – International Building Code
- C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.
1. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
 2. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
 3. DOE - Department of Energy; www.energy.gov.
 4. EPA - Environmental Protection Agency; www.epa.gov.
 5. FG - Federal Government Publications; www.gpo.gov.
 6. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
 7. OSHA - Occupational Safety & Health Administration; www.osha.gov.
- D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. FED-STD - Federal Standard; (See FS).

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

DIVISION 01 – GENERAL REQUIREMENTS

SECTION 015000

TEMPORARY FACILITIES & CONTROLS

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 temporary utilities, support facilities, and security and protection facilities.
- B. Contractor shall notify the Owner at least 7 days prior to any shut down of utilities.
- C. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.
- B. GC to provide Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. GC to provide Water Service from Existing System: Water from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- D. GC to provide Gas Service for Temporary Heat and Ventilation: Gas from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

- A. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
 - 1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.

2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Orange snow fencing used for separating occupant egress paths from construction areas. See logistics plan on civil drawings.
- B. 8 foot chain link with gates to surround construction and staging areas.

2.2 TEMPORARY FACILITIES

- A. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 1. Store combustible materials apart from building.
- B. Provide and service temporary toilets for construction operations.
- C. Provide fire protection during construction.
- D. Provide temporary heat and ventilation during construction.
- E. Provide temporary lighting with adequate light levels during construction. The service used from the existing building shall be limited to a 100 amp panel.
- F. General Contractor to provide a job and office trailer adequate in size to hold construction job meetings. General Contractor to keep one copy of all approved shop drawings in the job trailer.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 SUPPORT FACILITIES INSTALLATION

- A. General: Provide sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
- B. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- C. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- D. Sanitary Facilities: Provide temporary toilets, wash facilities and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation and maintenance of fixtures and facilities.
- E. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Enclosure Fence: Provide chain link fencing on the exterior of the building in areas where work is taking place.
- C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- D. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
- E. Fence Opening Protection: Fence openings are not to be left unprotected when construction crews are not present.

END OF SECTION 015000

DIVISION 01 – GENERAL REQUIREMENTS

SECTION 016000
PRODUCT 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 selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 014200 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

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

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.

5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product during the bidding phase.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

- C. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

DIVISION 01 – GENERAL REQUIREMENTS

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. Coordination of Owner-installed products.
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for limits on use of Project site.
 - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 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 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
 - a. Refer to Unit Specifications.
2. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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. Examine walls for suitable conditions where products and systems are to be installed.
 2. 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. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. 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.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. 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 Contractor, submit a request for information to Architect according to requirements in Section 013100 "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 property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

3.4 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.
- 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. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. 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.

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

3.5 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. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."
- 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. 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.
 3. Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place 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 and ensures thermal and moisture integrity of building enclosure.
- G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 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. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- 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 Section 017419 "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.
- K. **Provide final cleaning of all disturbed areas** including floors, walls, ceilings, casework, glass and frames.

3.7 STARTING AND ADJUSTING

- A. **Confirm proper operation of components.** 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.

3.8 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.**

END OF SECTION 017300

SECTION 017419

CONSTRUCTION WASTE MANAGEMENT & DISPOSAL

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 the disposing of nonhazardous construction waste.

1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

3.2 DISPOSAL OF WASTE

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

END OF SECTION 017419

DIVISION 01 – GENERAL REQUIREMENTS

SECTION 017700
CLOSEOUT 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 contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 017300 "Execution" for progress cleaning of Project site.
 - 2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.
 - 5. Submit test/adjust/balance records.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Perform preventive maintenance on equipment used prior to Substantial Completion.
 - 3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
 - 4. Participate with Owner in conducting inspection and walkthrough.
 - 5. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 6. Complete final cleaning requirements, including touchup painting.
 - 7. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, 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 identified by Architect, 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.

1.7 FINAL COMPLETION PROCEDURES

- A. Preliminary procedures: Before requesting final inspection for determining final completion, complete the following:
 - 1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
 - 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 - 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - 1. Organize list of spaces in sequential order, 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. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Architect, will return annotated file.
 - b. Three paper copies. Architect will return two copies.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) 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.
 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

1.10 ELECTRONIC CLOSEOUT DOCUMENTATION

- A. General: Provide a complete project Closeout Documentation Package in electronic format. This package shall include:
 1. Project Record Documents.
 2. Approved submittals.
 3. Operation and Maintenance Manuals.
 4. Warranties.
 5. Owner Training DVDs
 6. Project Contact Directory.
- B. The electronic Closeout Document shall be prepared by Digital Revolution/BHFX,LLC - Contact TJ Hurckes at 847-899-3414 or tj.hurckes@bhfx.net.
- C. In order to facilitate the Electronic Closeout Documentation process, comply with the following:
 1. Contact Digital Revolution a minimum of 3 months prior to the date of substantial Completion to schedule a pre-close out meeting. Review the following:

- a. Format of documents: PDF electronic format for all documents.
 - b. Folder structure for storage and transfer of files.
 - c. Schedule of collection and turn-over of closeout documentation.
 - d. Record Document format procedures: Provide clean and accurate paper copies of the marked up Record Documents (drawings and specifications) for scanning.
 - e. Provide contact information for the individual responsible for the collection and transfer of the electronic Closeout Documentation Package contents.
 - f. Review a complete listing of Closeout Documentation Package contents.
2. Provide all documentation to Digital Revolution for processing no later than 30 days after the date of substantial completion.
 3. Schedule a training conference with the Owner's representative, Architect, Program Manager and Digital Revolution to present the completed Electronic Closeout Documentation Package.
 4. Cost of this service will be paid by RPS 205 directly to Digital Revolution.

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: Perform 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 designated 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. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - c. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - d. 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.
 - e. Remove debris and surface dust from limited access spaces.
 - f. Sweep concrete floors broom clean in unoccupied spaces.
 - g. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - h. Clean transparent materials, including and in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish glass, taking care not to scratch surfaces.
 - i. Remove labels that are not permanent.
 - j. Leave Project clean and ready for occupancy.
- C. Construction Waste Disposal: Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
- 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

END OF SECTION 017700

DIVISION 01 – GENERAL REQUIREMENTS
SECTION 017839
PROJECT RECORD DOCUMENTS

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 project record documents, including the following:
1. Record Drawings.
 2. Record Specifications.
 3. Record Product Data.
- B. Related Requirements:
1. Section 017700 "Closeout Procedures" for general closeout procedures.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
1. Number of Copies: Submit one set of marked-up record prints.
 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and one of file prints.
 - 3) Submit record digital data files and one set of plots.
 - 4) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit one paper-copy sets of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints.
 - 3) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit one paper copy and PDF electronic files of Project's Specifications, including addenda and contract modifications.

- C. Record Product Data: Submit one paper copy and PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - 2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
 - 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 - 2. Format: DWG, Version, Microsoft Windows operating system.
 - 3. Format: Annotated PDF electronic file with comment function enabled.
 - 4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 - 5. Refer instances of uncertainty to Architect for resolution.
 - 6. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as scanned PDF electronic file(s) of marked-up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

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

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 017839

DIVISION 1 – GENERAL REQUIREMENTS

SECTION 024119 **SELECTIVE DEMOLITION**

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. Demolition and removal of selected portions of building or structure.
- 2. Demolition and removal of selected site elements.

B. Related Requirements:

- 1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
- 2. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse or store as instructed by Architect.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.6 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.3 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

2. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 3. Cover and protect furniture, furnishings, and equipment that have not been removed.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items (When requested by Architect):

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area on-site designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items (When requested by Architect):

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition, cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- D. Resilient Floor Coverings: Owner will remove asbestos containing flooring and non-asbestos flooring.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them according to Section 017419 "Construction Waste Management and Disposal."
 1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

DIVISION 03 – CONCRETE
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:

1. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, insulation and finishes.
2. Interior cast-in-place formed concrete stair and ramp.
3. Exterior cast-in-place concrete stoops.
4. Perimeter rigid insulation
5. Moisture mitigation requirements for new concrete slabs receiving new flooring.

- B. Related Requirements:

1. Section 033050 "Concrete Pavements" for exterior concrete pavement.
2. Section 035420 "Moisture Mitigation Underlayments"
3. Section 096513 "Resilient Flooring and Base".
4. Section 312000 "Earthwork" for drainage fill under interior 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 SUBMITTALS

- A. Process all submittals per requirements in Section 013300 – Submittal Procedures.
- B. Shop Drawings: Submit Shop Drawings pertaining to fabrication, bending and placement of concrete reinforcements.
1. Comply with the ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
 2. Show bar schedules, diagrams of bent bars, and arrangements of concrete reinforcement. Include special reinforcement required at openings through concrete structures.

- C. Test Reports: Submit 3 copies of laboratory test reports for concrete materials and mix design tests including potential for alkali-silica reaction (ASR).
- D. Product Data: Submit manufacturer's data on fiber reinforcement, additives, curing agents, sealers, grouts, joint materials and similar pre-manufactured products.
- E. Certificates: Submit purchase receipt verifying grade and quantity of under-slab vapor barrier.
- F. Concrete Truck Delivery Tickets: Submit delivery tickets indicating:
 - 1. Delivery date and time dispatched.
 - 2. Name and location of project.
 - 3. Name of Contractor.
 - 4. Name of ready-mixed concrete producer.
 - 5. Truck number.
 - 6. Number of cubic yards of concrete in load.
 - 7. Class of concrete.
 - 8. Cement content in bags per cubic yard of concrete.
 - 9. Type and brand name of cement.
 - 10. Names and quantities of admixtures used.
 - 11. Maximum size of aggregate.
 - 12. Amount of water added at job, if any, and who authorized the addition.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Cooperate with other trades regarding installation of embedded items. Obtain templates, dimension, instructions, etc., from other trades or other contractors as required for setting items in concrete work.
- D. The Owner shall employ a reputable testing laboratory to perform concrete inspections and tests as hereinafter specified. The costs for testing shall be paid for by the Owner, except as hereinafter specified under FIELD QUALITY CONTROL TESTS.
- E. Comply with the latest edition of each of the following:
 - 1. "Building Code Requirements for Reinforced Concrete" (ACI 318).
 - 2. "Specifications for Ready Mixed Concrete" (ASTM C 94).
 - 3. "Guide to Concrete Floor and Slab Construction" (ACI 302.1).
 - 4. "Recommended Practice for Hot Weather Concreting" (ACI 305).
 - 5. "Recommended Practice for Winter Concreting" (ACI 306).
 - 6. "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete" (ACI 304).
 - 7. "Specifications for Structural Concrete for Buildings" (ACI 301).

- F. Inform personnel that may be working with concrete as to requirements and the availability of ACI 301.
- G. Provide protection during the construction period for all floor slabs, from oil, grease, stains, discoloration and other physical damage.
- H. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 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.
- B. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

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.

- B. Moisture Mitigation of New Concrete Slabs: The General Contractor is responsible for the pouring and curing of the new concrete slabs so the slabs have moisture levels below the required levels prior to installing the new flooring. The General Contractor is responsible for providing moisture mitigation to the new slabs as required if the slabs moisture levels are too high. A delay in the project will not be accepted due to high unacceptable moisture levels in the slab. See Section 003542 Moisture Mitigation Underlayments for acceptable products and procedures to use to mitigate the moisture. See individual flooring specifications for moisture testing requirements. All above work shall be included in the Base Bid.

2.2 FORM MATERIALS

- A. Form Facings for Unexposed Concrete: Plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- B. Form Coatings: Commercial formulation intended for form coating which will not bond with, stain, or adversely affect concrete surfaces, and which will not impair bond or adhesion of subsequent treatments nor impede wetting of surfaces to be cured with water or curing compound.
- C. Form Ties:
 - 1. 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. Configured so as to leave no metal closer than 1" to the surface of the concrete.

2.3 STEEL REINFORCEMENT

- A. Materials
 - 1. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
 - 2. Tie Wire: Cold drawn steel wire meeting ASTM A 82.
 - 3. Welded Wire Fabric: Per ASTM A1064.
 - 4. Reinforcing Bar Holders: Galvanized or plastic coated when within 3/4" of exposed concrete surface.
- B. Fabrication:
 - 1. No lapped splices for tension and compression bars unless noted on the Drawings or approved. Locate splices in temperature bars so that no more than half the bars are spliced at any point. Lap splices 36 diameters.
 - 2. Label bars to identify grade of steel and to facilitate placing.
- C. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I for normal and Type III for high-early-strength.
- B. Mixing Water: Fresh, free of oil, acid, alkalis, salts, organic matter and potable.
- C. Aggregates: Per ASTM C 33, including freedom from potentially reactive constituents, as well as soft, thin elongated or laminated pieces, disintegrated stone, plant matter, trash and lumps of frozen or partly cemented material.
 - 1. ASR Tested: Per ASTM C 1260. Submit test results.
 - 2. Fine Aggregate: Natural hard, clean sand.
 - 3. Coarse Aggregate: Gravel or crushed rock.
 - a. Size 57 (1-1/2" top size) for structural elements 6" or more in thickness.
 - b. Size 67 (3/4" top size) for slabs.
 - 4. Furnish 3 copies of testing laboratory reports showing sieve analysis.
- D. Admixtures:
 - 1. Air-Entraining Admixture: Per ASTM C 260. Use one of the following:
 - a. "Darex AEA" by W.R. Grace.
 - b. "Sika AER" by Sika Chemical Corp.
 - c. "MB-VR" by Master Builders Co.
 - 2. Water-Reducing Admixtures: Per ASTM C 494; one of the following:
 - a. "Pozzolith" by Master Builders Company.
 - b. "Plast-o-Crete" by Sika Chemical Co.
 - c. "WRDA" by W.R. Grace.
 - 3. Calcium Chloride: Shall NOT be used. Neither calcium chloride nor admixtures containing chloride salts shall be added to concrete.

2.5 ACCESSORY MATERIALS

- A. Rigid Perimeter Foundation Insulation: Closed cell extruded polystyrene foam board insulation 3" thick, complying with ASTM C 578, Type IV, in manufacturer's standard sizes.
 - 1. Minimum R-value, per 1" thickness at 40°F: 5.4.
 - 2. Minimum compressive strength: 25 psi.
 - 3. Maximum water absorption: 0.15% by volume.
- B. Vapor Retarder (Moisture Barrier):
 - 1. Black low-density polyethylene film 10 mils (.010") thick.
 - a. "Stego Wrap (10 mil)" by Stego Industries.
 - b. "EcoShield E-10" by Epro Services.
 - c. "Iron Barr 10mil" by FlatIron Films.
 - d. "Perminator 10 mils" by W.R. Meadows.
 - 2. Joint and Sealing Tape: Moisture barrier manufacturer's recommended tape.

C. Curing Materials:

1. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., conforming to AASHTO M 182, Class 3.
2. Moisture-Retaining Cover: Waterproof paper, polyethylene film or polyethylene coated burlap conforming to ASTM C 171.
3. Curing Compound: Liquid, membrane forming compound conforming to ASTM C 309, Type 1, with fugitive dye, and guaranteed to not affect the bond, adhesion or effectiveness of floor hardeners or other applied finishes or surface treatments. Product shall be one of the following:
 - a. "Masterseal" by Master Builder's Co.
 - b. "Kure-N-Seal" by Sonneborn.
 - c. "Sika-Gard C/H" by Sika Chemical Co.
 - d. "CS-309" by W.R. Meadows.
 - e. "Clearbond" by Guardian Chemical Co.
 - f. "Resi Chem Clear Cure" by Symons Corp.

D. Sealer: Non-epoxy type conforming to ASTM C 309 and Fed. Spec. TT-C-800A and compatible with curing methods. Furnish from one of the following products and include manufacturer's standard guarantee:

1. "Kure-N-Seal 30" by Sonneborn.
2. "TIAH" by W.R. Meadows.
3. "Clearbond" by Guardian Chemical Co.
4. "Cure & Seal" by Symons Corp.

E. Dovetail Inserts: Sheet metal inserts conforming to ASTM A1008 and galvanized per ASTM A653 Class G60 (0.6oz/ft²):

1. "Dovetail Anchor Slots: Hot dipped galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.6 PROPORTIONING AND DESIGN OF MIXES

- A. Use an independent testing facility experienced in concrete mix design and acceptable to Owner for preparation of proposed mix designs. The testing facility shall not be the same used for field quality control testing unless otherwise acceptable to Owner.
- B. Allow a minimum of 14 days prior to placing concrete for testing laboratory to design the mix for each type of concrete required.
- C. The adequacy of the design mix shall be verified by tests on a minimum of 6 cylinders; 3 tested at least 7 days and 3 at 28 days in accordance with ASTM C 192 and C 39 and by slump tests in accordance with ASTM C 143.
- D. Submit 3 copies of the mix design and test results to Owner's Representative for review before any concrete is placed.
- E. Concrete for Slabs on Grade: Add 1.5 lbs of fiber reinforcement per cubic yard except where wire mesh reinforcement is to be used.

- F. Concrete for exterior stoops and foundations shall have a maximum water-cement ratio of 5-1/4 gallons per bag and shall maintain a slump of 3". Incorporate an air entraining admixture yielding a total air content by volume of 4.5% to 7.5% for 3/4" top-sized aggregate and 4% to 7% for 1-1/2" top sized aggregate. Refer to drawings for compressive strength.
- G. Concrete for slabs and interior foundations shall have a maximum water-cement ratio of 6-1/2 gallons per bag and shall maintain a slump no greater than 4". Refer to drawings for compressive strength.
- H. Calcium chloride or admixtures containing chloride salts shall not be used.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Mix and transport in accordance with ASTM C 94, "Specification for Ready-Mixed Concrete" and the established mix design.
- B. Batch mixing at the site will not be allowed except on prior approval
- C. Use admixtures only as specified in the established mix design.

PART 3 - EXECUTION

3.1 RIGID PERIMETER FOUNDATION INSULATION

- A. Apply insulation to the inside of exterior foundation walls, from under the floor slab down to the top of the footing. Apply insulation under the floor slab as shown on the drawings.

3.2 VAPOR-RETARDER INSTALLATION

- A. Install vapor barrier directly under all interior concrete slabs on grade. Place barrier over the granular fill just before placement of the concrete; but do not place barrier until the granular fill has been inspected for compaction and grading per the requirements of Section 312000 - Earthwork for Building.
- B. Lap the membrane sheet edges at least 12", with the top placed in the direction of the spreading of the concrete, and seal each seam continuously with approved waterproof tape. Turn membrane up on to wall and seal with tape to wall.
- C. Seal all around pipes, conduits and other penetrations with tape.
- D. Apply tape only to dry surfaces cleaned of dirt and other contaminants.
- E. Just before membrane is to be covered, inspect membrane and repair all tears and visible holes with membrane manufacturer's recommended sealing tape. For tears more than 12" long, lap a scrap piece of material to 12" beyond each side of the tear and seal all of the edges with tape.

3.3 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.
- 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. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- H. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- I. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.4 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of walls, 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.
 - 1. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- 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.

3.5 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
 - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.6 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.
 - 1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- 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.

3.7 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. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. 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.

3.8 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. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- D. 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.

- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Concrete slabs shall not slope to drains. Drains to be set level with floor.
 - 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.

3.9 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.
 - 2. Prepare exterior face of perimeter wall which is to receive membrane waterproofing.

3.10 FINISHING FLOORS, SLABS AND STOOPS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated to receive trowel finish.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces exposed to view.
 - 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - 3. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft. long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

- E. Broom Finish: Apply to exterior concrete stoops.
 - 1. After the concrete has been floated and is sufficiently harden such that broom marks will not be more than 1/16" deep, brush surface with a stiff, medium bristled broom. Make the broom strokes all in one direction. Make broom strokes on sloped surfaces perpendicular to direction of slope.

3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m 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. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 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.

3.13 MISCELLANEOUS CONCRETE WORK

- A. Exterior Door Stoops:
 1. The stoop foundations shall be a minimum depth of 4'-0" with No. 4 bars at 12" o.c. as minimum reinforcement. Slab shall be minimum thickness of 4" and the walls shall be a minimum thickness of 6". Provide 1/2" preformed filler strips in joints at junctions with walls, walks, etc., where shown. Hold top edge of filler strips 1/2" below finished surface of concrete.
 2. Provide No. 4 dowels at 12" o.c. into platform slabs from building foundation wall.
 3. Slope stoop slabs 1/8" to 1/4" per foot to drain away from building.
 4. All stoops shall be provided with expansion joints and/or control joints as indicated on the Drawings and/or as directed by the Architect.

3.14 FIELD QUALITY CONTROL

- A. Cooperate with the laboratory in every respect by arranging material for sampling and supplying necessary facilities at the job site for making the field tests and storing specimens.
- B. Tests shall be made for each 50 cubic yards of concrete or fraction thereof, but not less than 2 for each day's pour. Perform the following tests:
 1. Compression Test: Make a minimum of 3 standard 6"x12" cylinders for testing, one at the age of 7 days, and one for testing at 28 days, unless otherwise directed. If compression tests are to be used for determining when forms may be removed, make at least 2 additional cylinders and cure on job site in accordance with ASTM C 31.
 2. Tests for Air-Entrainment: Per ASTM C 231, on a random basis, as determined by the Owner's Representative.

3. Slump Test: Per ASTM C 143. Contractor shall provide cone and make tests whenever requested by Owner's Representative. Test each and every truckload. 1/2" tolerance allowed each way.
 4. Additional Tests: If, in the opinion of the Owner's Representative there is any question as to the quality of the concrete already placed, make additional tests as directed. Tests may be either compression tests on cored cylinders, per ASTM C 42; or load tests as outlined in ACI 318; or as directed. These tests shall be paid for by the Contractor.
- C. Evaluation of Tests: In accordance with ACI 214-83.
- D. Test Reports: Furnish for all tests. Report must show exact location of work represented by samples and tests.

END OF SECTION 033000

SECTION 035420

MOISTURE MITIGATION UNDERLAYMENT

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. Two-Component, Epoxy Based Moisture Mitigation System.
 - 2. 2-Component Crack Repair Compound.

- B. Related Requirements:

- 1. Section 033000 "Cast-In-Place Concrete" for concrete slabs on grade.
 - 2. Section 096513 "Resilient Flooring and Base" for resilient flooring on concrete slabs-on-grade.
 - 3. Section 096813 "Carpet Tile" for carpeting on concrete slabs-on-grade.

1.3 SUBMITTALS

- A. Test Reports: Submit results of field slump test.
- B. Submit manufacturer's product data describing all components. Include manufacturer's recommendations for installation.
- C. Certificates: Submit verification that applicator is a manufacturer certified installer.

1.4 QUALITY ASSURANCE

- A. Installation of the **Schönox EPA Two-Component, Epoxy Based Moisture Mitigation System** must be done by a qualified installer, using equipment and tools recommended by the manufacturer.
- B. Substitutions: Manufacturer other than the ones specified shall have available for inspection by Owner an existing installation of the type proposed which has been in use for at least a full year. The proposed manufacturer must be able to demonstrate that the flooring can be leveled so as to produce a seamless "invisible" patch, well bonded to the existing concrete floor. Substitution must meet or exceed Schonox system herein and be approved by Architect 10 days prior to bid opening.
- C. **Schönox EPA** shall be installed only over a porous concrete slab, and can be installed over new concrete that is only 7 days old.

- D. **Schönox EPA** shall be installed over smooth, sound, clean, dry and free of any contaminants, which may hinder adhesion. Power floated screeds with a “shiny” finish should be mechanically prepared to a CSP of 2-3 prior to use of **Schönox EPA**. Surface treatments or any friable areas of the subfloor must be mechanically removed and the subfloor repaired with **Schönox** underlayments as required. Repair non-structural cracks with **Schönox PGH 2-Component Crack Repair Compound**.
- E. Prior to beginning the installation of measure the relative humidity with the concrete (ASTM F2170). Alternatively, you can measure the surface relative humidity in accordance with ASTM F2420. For these relative humidity methods, the RH shall not exceed 100%.
- F. **Schönox EPA** is based on a 2-component epoxy resin that provides excellent penetration, has a high sealing function, short waiting time and is solvent free. **Schönox EPA** is applied in one coat with a squeegee moving slowly to ensure that an even coat is established, after 15-30 min, using a saturated 3/8” nap roller, backroll the area:
 - 1. One coat for moisture readings up to 100% RH or 25 lbs.
- G. Sand broadcast or an application of **Schönox SHP** is necessary before installation of **Schönox** underlayments.
- H. **Schönox** underlayment must be installed on the **Schönox EPA** in accordance with manufacturer’s recommended specifications for use and installation.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General requirements: Materials shall be delivered in their original, unopened packages and protected from the elements. Avoid extreme hot or cold, direct sunlight and moisture. Protect liquids from freezing. Damaged materials shall be removed from the job site.

1.6 FIELD CONDITIONS

- A. **Schönox EPA** involves the use of epoxies and cementitious materials. Observe the basic rules for working with epoxies and concrete. Do not install below 50°F working and substrate temperature.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS & MANUFACTURERS

- A. Manufacturer: **Schönox EPA System**. Or approved equal, for all products listed within this specification section.

2.2 MATERIALS

- A. The 2-component epoxy based resin moisture mitigation system shall be **Schönox EPA**.
- B. The Portland cement-based underlayment shall be an Schönox product, such as **Schönox US Cement Based Self Leveling Compound** suitable for intended use. See flooring specifications regarding compatibility with adhesives and flooring types.
- C. To fill non-structural cracks and joints, the polyester resin and hardener shall be **Schönox PGH 2-Component Crack Repair Compound**. For instructions on the filling of non-structural cracks and joints, follow the written instructions of the manufacturer and must receive a sand broadcast.
- D. All moving joints and cracks must be honored up through the moisture control system, **Schönox** underlayment and floor covering

2.3 MIX DESIGNS

- A. **Schönox EPA** 2-Component System includes 1.47 gallon of Component A (resin) in a metal canister and 0.96 gallon Component B (hardener) in metal canister. Full units shall be mixed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The concrete slab must have an intact and functioning vapor retarder.
- B. Prior to beginning the installation, measure the relative humidity within the concrete (ASTM F2170). Alternatively, you can also measure the surface relative humidity in accordance with ASTM F2420. For these relative humidity methods, the RH shall not exceed 100%.
- C. Subfloors must be smooth, sound, clean, dry and free of any contaminant, which may hinder adhesion. Any loose areas must be mechanically removed back to a sound base and substrate.
- D. Old water-soluble adhesives should be removed completely; old water resistant adhesives should be mechanically removed as far as possible. The complete mechanical removal of cutback (i.e. grinding or sanding) can be hazardous as old cutback adhesives may contain asbestos. Consult with government agencies for removal of flooring adhesives that contain asbestos.
- E. Do not use a vapor barrier on gypsum-based substrate.

- F. All cracks and non-moving joints in the subfloor shall be repaired with **Schönox PGH** as required.
- G. It is the responsibility of the flooring contractor to ensure that the subfloor is thoroughly clean and properly anchored prior to the installation of any **Schönox** products

3.2 CRACK AND JOINT PREPARATION

- A. Non-moving cracks and saw-cut joints: To ensure that a continuous barrier to moisture emissions is created over the entire service, **Schönox** recommends the use of a 2-component crack repair compound such as **Schönox PGH** to fill small, non-moving cracks and saw-cut joints in existing concrete substrates. Fill cracks and dummy joints in strict accordance with the installation instructions provided in the **Schönox** technical data sheet. Once the cracks and dummy joints are filled, allow these areas to cure thoroughly in accordance with the manufacturer's recommendations prior to proceeding with **Schönox EPA** installation.

3.3 MIXING AND APPLICATION

- A. **Schönox EPA** 2-Component System includes 1.47 gallon of Component A (resin) in a metal canister and 0.96 gallon Component B (hardener) in metal canister. Full units shall be mixed.
- B. Thoroughly mix the **Schönox EPA** resin (Component A) with the **Schönox EPA** hardener (Component B) to a homogenous mix using a mixer (approx. 300 rpm). Refill the mixed material into a clean bucket and mix again for approx. 1 minute.
- C. Apply **Schönox EPA** to the concrete surface with a squeegee and let it dwell for 15-30 minutes before saturating a suitable long piled 3/8" nap roller and back rolling it.
- D. In place of silica sand prime with **Schönox SHP** after drying following the referring product data sheet.
- E. After approx. 12 hours the substrate is ready for applying a **Schönox US** leveling compound at 1/8" thickness, or approved equal. **Schönox SHP** must be used to prime the epoxy prior to applying **Schönox US**. **The US product is required, as a porous leveling & skim coat product, based on the adhesives and flooring finishes being used.** Follow the manufacturer's specifications and installation instructions for both SHP and US products.
- F. Install **Schönox** underlayment and patches in accordance with the printed instructions found in the corresponding **Schönox** technical data sheets.

3.4 FIELD QUALITY CONTROL

- A. Where specified, field sampling of **Schönox** leveling compounds is to be done by taking an unopened unit or bag of the product being installed to an independent testing facility to perform the specified testing. There are no in situ test procedures for the evaluation of the materials specified.

3.5 PROTECTION

- A. Prior to installation of the underlayment and finished flooring, the surface of the system shall be protected from abuse by other trades by use of plywood, Masonite or other suitable protection.

END OF SECTION 035420

SECTION 042000
UNIT MASONRY

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. Concrete masonry units.
- 2. Face brick.
- 3. Cast Stone cap.
- 4. Mortar and grout.
- 5. Steel reinforcing bars.
- 6. Masonry-joint reinforcement.
- 7. Embedded flashing.
- 8. Miscellaneous masonry accessories.
- 9. Anti-Graffiti Coating for new exterior brick

B. Related Requirements:

- 1. Section 033000 "Cast-in-Place Concrete" for masonry setting.
- 2. Section 055000 "Metal fabrications" for loose lintels.
- 3. Section 072726 "Fluid Applied Membrane Air Barriers" for cavity wall air barrier.
- 4. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured installed in masonry joints.
- 5. Section 078400 "Firestopping" for firestopping at masonry walls.
- 6. Section 079200 "Joint Sealants" for sealants associated with masonry.
- 7. Section 081113 "Hollow Metal Doors and Frames" for hollow metal frames set in masonry walls.
- 8. Section 084113 "Aluminum Framed Entrance" for aluminum door frames set in masonry wall.
- 9. Section 085113 "Aluminum Windows" for aluminum window frames set masonry walls.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Stone Cap: Show sizes, profile.
 - 3. Cavity wall insulation.
 - 4. Masonry ties and reinforcing steel.
 - 5. Fabricated In-wall and thru-wall flashing.
 - 6. Mortar and grout materials including additives.
 - 7. Mortar and grout mix compositions.
 - 8. Masonry control joint accessories.
 - 9. Anti-graffiti coating.
- B. Submit laboratory test results for mortar and masonry units including design data for grout mixes when grout is to be pumped.
- C. Certificates: Along with Product Data submit:
 - 1. Letter of certification from each block manufacturer confirming that the block supplied to the site will be manufactured in the same manner as block tested and found to conform to the performance requirements specified herein below. Attach test reports to letter.
 - 2. Letter of certification from manufacturer of horizontal joint reinforcing confirming the quality of coating(s) furnished on the products delivered to the site.
- D. Samples for Verification: For each type and color of the following:
 - 1. Face brick.
 - 2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
- E. Qualification Data: For testing agency.
- F. Material Certificates: For each type and size of the following:
 - 1. Masonry units: Include data on material properties
 - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 3. Mortar admixtures.
 - 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 5. Grout mixes. Include description of type and proportions of ingredients.
 - 6. Reinforcing bars.
 - 7. Joint reinforcement.
 - 8. Anchors, ties, and metal accessories.
 - 9. Anti-graffiti coating
- G. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.

2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- H. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- I. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 CODES AND STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with:
 1. Standards of masonry installation described in the recommendations of:
 - a. National Concrete Masonry Association (NCMA).
 - b. Masonry Standards Joint Committee (MSJC) Spec. (ACI 530.1/ASCE 6/TMS 602).
 2. Cast Stone: ASTM C1364..
- B. Fire-Rated Masonry: Wherever a fire-resistance classification is shown or scheduled for unit masonry construction (2-hr., U.L. Design Nos., and similar designations), comply with the masonry materials and installation requirements established by the relevant governing authorities for the constructions shown.

1.6 QUALITY ASSURANCE

- A. Sources of Supply: Obtain each kind of masonry units from one manufacturer, of uniform texture and color or uniform blend in the variation thereof, for each kind required, for each continuous area or visually related areas.
- B. Coordination: Coordinate with concrete installers with respect to installation of bar reinforcement in concrete foundations to be extended up into reinforced masonry walls.
- C. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
 1. Build sample panels for typical exterior wall in sizes approximately 48 inches long by 48 inches high by full thickness.
 - a. Include a sealant-filled joint at least 16 inches long.
 - b. Include through-wall flashing installed for a 24-inch length.
 2. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
 3. Protect approved sample panels from the elements with weather-resistant membrane.

4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.
5. Subject to compliance with requirements, approved sample panel may become part of the completed Work if undisturbed at time of Substantial Completion.
6. Apply the anti-graffiti coating on a portion of the new exterior brick as designated by the Architect for a test area.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
- F. Clean all brick surface prior to installing the Anti-graffiti coating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 UNIT MASONRY

- A. Field Face Brick:
1. Field: W72 4x8x8 Stylo by Glen-Gery or Owner approved equal during the bidding phase.
 2. Quality Standard: ASTM C 216-91c, Grade SW, Type FBX.
- B. Glazed Brick (Accent):
1. Glazed brick shall conform to ASTM C216-91c, Grade SW, Type FBX, for body and ASTM C126, Type I, for glaze. Glazed brick shall be 350 Glazed Modular Cored size units as manufactured by the Hanley plant of Glen-Gery Corp or Owner approved equal during the bidding phase.
 - a. Size: Stylo 3 5/8" thick x 7 5/8" high x 7 5/8" long.
 - b. Color: G82-288.
 - c. Shapes: All internal corners shall be square unless otherwise noted. Provide miters and other special shapes as detailed.

- C. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- D. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

2.3 CONCRETE MASONRY UNITS

- A. Concrete Masonry Units, except as otherwise indicated:
 - 1. Type: Standard hollow load and solid load bearing units made with ASTM C 33 aggregates to conform to ASTM C 90, Grade N, Type 1, including a total linear drying shrinkage less than .045%.
 - 2. All block units shall be light weight block of 8" x 16" nominal face size; thicknesses as indicated.
 - a. Provide bullnose block on external corner and jamb units and other special conditions as shown. Furnish same square cornered units for sills and heads (installed on-end).
 - b. Provide special shapes where shown and where required for lintels, bond beams and other special conditions.
 - c. Provide scored block (scored 8" o.c. vertically to make two units per block) where indicated on drawings.
 - 3. Texture: Face textures of each type of block shall match each other.
 - 4. Cores: 2-core or 3-core block may be used.
 - a. Provide solid block, where required, with core area not exceeding 25% of gross cross sectional area.
 - 5. Moisture Limits: Units shall be cured in a moisture-controlled atmosphere so that when delivered to job site the weight of water contained in the units shall not exceed 35% of the fully saturated capacity of the block.
 - a. Moisture content of units stored at the site shall be maintained so as to not exceed 35% of block saturation capacity when tested by Owner's testing laboratory.

2.4 STONE CAP

- A. Stone Cap: Cast stone meeting ASTM C1364, as manufactured by Heritage Cast Stone or Owner approved equal during the bidding phase.
 - 1. Finish: Smooth.
 - 2. Color as selected by Architect from manufacturers standard color.
 - 3. Sizes and Shapes: As detailed on drawings.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, non-staining, Type I or Type III (as required for cold weather conditions), natural gray.
- B. Masonry Cement: Not permitted.
- C. Hydrated Lime: Conforming to ASTM C 207, Type S.
- D. Sand: Conforming to ASTM C 144, except that 100% shall pass the #8 sieve and 15% - 30% shall pass the #50 sieve.
- E. Grout Aggregate: Gravel or crushed stone well graded from 3/8" to #16 and conforming to ASTM C 404. When fine aggregates are required, conform to ASTM C 404.
- F. Additives: Not allowed, including calcium chloride or other chloride bearing formulations, as well as any air entraining agents except for Water Repellent Additive: W.R. Grace "Dry-Block Mortar Additive" or equal approved by Architect.
- G. Water: Clean, potable, free from oil, soluble salts, acids, alkalis, organic impurities and other deleterious materials.

2.6 MORTAR AND GROUT MIXES

- A. Mortar Mix Properties:
 - 1. Mortar (lime-cement mortar) per ASTM C 270: Proportion portland cement, damp loose sand, and hydrated lime, by volume to achieve average, in-field, not lab compression strength of 2100 psi at 28 days. Refer to drawings for mortar type.
 - 2. Submit specimens for testing when directed by Architect.
- B. Grout Mix Proportions:
 - 1. For Embedment of Reinforcing Bars: Coarse Grout per ASTM C 476.
 - 2. For Filling Hollow Metal Door Frames: Use mortar, the same as used for adjacent masonry. Where hollow metal frames abut solid construction and filling must be done through a funnel, add sufficient water to mortar to produce a soupy consistency. Fill frames with grout after the frames have been installed.
- C. Mixing:
 - 1. Measurements: Measure ingredients precisely.
 - a. Keep water-cement ratio precise from batch to batch.
 - b. Accurately measure sand in damp, loose condition; measurement of sand by shovelful will NOT be allowed. Allow for contraction and expansion of sand's volume as it dries out and it gains moisture.
 - 2. Mortar: Mix mortar in a motorized mechanical batch mixer. Ingredients shall be thoroughly mixed according to ASTM C 270 procedures for at least 3 minutes but not more than 5 minutes after all material is in the mixer. Mix only as much mortar as needed for immediate use.
 - a. Cold Weather: When air temperature is 40°F or below, keep water warmed to above 70°F but do not allow it to exceed 160°F. When heating sand, heat slowly and evenly. Scorched sand shall be discarded.
 - b. Exterior Mortar: Add color pigments as required to match the sample selected by Architect.

3. Grout: grout thoroughly in a mechanical batch mixer according to ASTM C 476 procedures; hand mixing not allowed without approval. Grout may be premixed and delivered per ASTM C 94. Use only enough water to produce a workable consistency, except that for placement by pump more water may be added.
 - a. Cold Weather: When air temperature is 40°F or below, mix grout according to cold weather restrictions for mortar, and deliver at 70°F-120°F.
4. Admixtures: Do not use admixtures except as specifically allowed by Architect and approved by Owner.
5. Pre-Mixed Mortars: Truck delivered batch mixing shall conform to ASTM C 1142. In addition to regular motorized mixers, Spec-Mix systems may be used. "SILO-MIX" WILL NOT BE ALLOWED.
6. Mortar Mixers, Boxes and Tools: Keep clean; thoroughly clean equipment and tools between batches and at end of each day's work.

D. Retempering:

1. Partially hardened mortar may be re-tempered to replace water lost through evaporation.
2. Do not retemper mortars out of mixer for more than 2-1/2 hours; but, rather, dispose of such mortar.
3. Repointing mortar shall be used within 30 minutes of final mixing; do not retemper or use partially hardened repointing mix.

2.7 REINFORCEMENT AND TIES

A. Acceptable Manufacturers: Subject to compliance with requirements of Specifications and Drawings, provide products by one of the following:

1. AA Wire Products.
2. Dur-O-Wal.
3. Heckman Building Products.
4. Hohmann & Barnard.
5. National Wire Products.
6. Masonry Reinforcing Corp. of America (Wire-Bond)

B. Exterior Cavity Wall Reinforcement: Factory welded ladder units with pintle eye extensions 16" o.c. placed to fit at the face of the cavity insulation.

1. Wire Type and Finish: Complying with ASTM A 82, all hot-dip galvanized after fabrication per ASTM A 153, Class B2 (1.50 oz per sq ft).
2. Side Rods: Two deformed #9 wires.
3. Width: 2" less than nominal thickness of backup wythe.
4. Pintle Ties: Double legged 3/16" wire box ties sized to extend at least 1-1/2" into masonry veneer while providing at least 5/8" mortar cover after tooling.

C. Corners and Intersections for Horizontal Joint Reinforcement: Factory fabricated matching "L" and "T" units only. Field fabricated corner units and lapped units at corners and intersections NOT allowed.

D. Bar Reinforcement:

1. Reinforcing Bars: Deformed new billet steel bars conforming to ASTM A 615, Grade 60.
2. Reinforcing Bar Positioners: Prefabricated units formed from #9 galvanized steel wire, specifically fabricated for holding steel reinforcing bars in proper relationship to block cores.

2.8 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.

2.9 EMBEDDED FLASHING MATERIALS

- A. Flashing For In-Wall And Thru-Wall Conditions: 40 mil rubberized asphalt membrane, faced with a cross-laminated polyethylene film 8 mil thick on one side. Use one of the following:
1. W.R. Grace "Perm-A-Barrier"
 2. Mirafi "Miradri TWF"
 3. Nervastral "Bitu-Rap"
 4. Polyguard "400 Flashing"
 5. Dur-O-Wal "Dur-O-Barrier-44"
 6. Carlisle "CCW-705-TWF"
 7. W.R. Meadows "Air-Shield (40 mils)"
 8. or Owner approved equal during the bidding phase.
- B. Surface Primer: Flashing membrane manufacturer's recommended surface conditioner.
- C. Mastic Sealant: Flashing membrane manufacturer's recommended mastic sealant for repairing membrane and sealing edges, joints and punctures.
- D. Metal Drip: Stainless steel sheet metal strip fabricated with hemmed drip edge, equal to "Partial Edge" by Dur-O-Wal or "Drip Edge" by Polyguard.
- E. Setting Mastic For Metal Drip: Same mastic as used for repair of flashing membrane.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Cavity Wall Insulation:

1. Rigid Polyisocyanurate Boards: Foil Faced, 48" wide complying with ASTM C 1289, Type 1, Class 2. boards shall have a minimum R-value of 6.5 per 1" thickness at 40°F, and minimum compressive strength of 25 psi, as well as a maximum water absorption of 0.10% by volume: Acceptable product and manufacturer; Thermax Sheathing by Dow Chemical Co. or comparable product as approved by Architect.
2. Thickness: 3" unless specified otherwise.
3. Joint Tape: 3M's "Contractor Sheathing Tape 8086 or as recommended by Insulation board manufacturer"

- B. Expansion and Control Joint Accessories: Refer to 079200 for joint filler material.
- C. Compressible Joint Filler: Fire rated mineral fiber insulation, full width and thickness of joint.
- D. Mortar Net: 10" high x 1 1/2" thick dovetail polyester material; "Mortar Net" by Mortar Net or "Mortar Net" by Sandell Mfg. Company, Inc. or Owner approved equal during the bidding phase.
- E. Cell Vents: 3/8" x 2 1/2" x 3 3/8" polypropylene plastic, color as selected by Architect from manufacturer's submitted color samples; "Cell Vent" by Sandell Mfg. Company, Inc. or Owner approved equal during the bidding phase.
- F. Fluid applied membrane air barrier as specified in Section 072726.
- G. Anti-Graffiti Coating: "Defacer Eraser Sacrificial Coating SC-1" by Prosoco or Owner approved equal during the bidding phase.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

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

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:

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

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.

C. Joints:

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

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Concrete Block: Unless otherwise indicated, lay exposed masonry in running bond to match existing; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Bond Pattern for Exposed Face Brick: Unless otherwise indicated, lay exposed face brick in stacked bond to match existing.

- D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs. **Stopping and Resuming Work:** Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. **Built-in Work:** As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints to match existing when thumbprint hard.

3.6 CAVITY WALL CONSTRUCTION

- A. **Back-Up Wythe:**
 - 1. Build block backup first and tool the joints concave on both faces.
 - 2. Tool the mortar tightly around the stems that hold the pintle eyes.
 - 3. Carefully locate horizontal joint reinforcing in the back-up wythe so that when the pintles are inserted into the pintle eyes, the pintles will fit tightly against the face of the cavity insulation.
- B. **Fluid Applied Membrane Air Barrier:** Fluid Apply the fluid air barrier as described in Section 072726.
- C. **Insulation:** Fit boards tightly between metal pintle eyes just before placement of pintle ties. Butt joints as tightly as possible and stagger vertical joints between courses.
 - 1. Joints: Tape over all joints with 3M's "Contractor Sheathing Tape 8086.

2. Corners: At major outside and inside corners of the building, extend the insulation boards across the cavity to the inside face of the exterior wythe, to block air movement around the corner.
- D. Veneer Wythe: Build brick veneer after joints in backup block have been tooled.
1. Place additional ties adjacent to each side of window and door openings, within 12" of jambs, spaced a maximum of 16" o.c. vertically.
 2. Tie Embedment: Do not lay tie on brick and top with mortar; rather, embed ties into mortar.
 3. Veneer Reinforcement: Provide longitudinal wire reinforcement in concrete block veneer wythe, spaced 24" o.c. vertically. When not using ties with seismic clips and attached wire, provide ladder/truss reinforcing in the horizontal joints 16" o.c., alternating between the joints that contain ties.
 4. Tops and Bottoms of Walls: Place joint reinforcement continuous in first and second joint above bottom of walls and below top of walls.
 5. Openings: Place masonry joint reinforcement in first and second horizontal joints above and below openings, extending reinforcement at least 16" beyond each side of opening.
 6. Joining Reinforcement Wires: Lap ends a minimum of 6". Continue wire around corners. Do not join wires when within 18" of a corner.
- E. Cavity: Provide not less than a 1-1/2" air space between brick veneer and cavity insulation.
- F. Keep cavity clean of mortar droppings by beveling the bed mortar to incline towards the cavity. Excessive mortar droppings into cavity will not be tolerated.
1. Cavity Bottoms: At flashing at base of wall and over each thru-wall flashing, provide a course of "Mortar Maze" after the first course of block has been applied above the flashing.
- G. Cavity Cells: Block off the cavity at major outside and inside corners with vertical strips of foam backer rod in order to prevent air flow around the corners. Locate backer rods within 4ft of corners. In similar fashion, block off the cavity between corners so that no expanse of cavity exceeds 20 feet horizontally.
- H. Weep and Vents:
1. Bottom Vents: Provide cavity vents at bottom of wall by leaving empty head joints at 32" o.c.

3.7 MASONRY-JOINT REINFORCEMENT

- A. Horizontal Joint Reinforcement: Reinforce concrete block and face brick walls as follows:
1. Typical Spacing: Install wire reinforcement in horizontal joints, spaced 16" o.c. vertically.
 2. Tops and Bottoms of Walls: Place joint reinforcement continuous in first and second joint above bottom of walls and below top of walls.

3. Openings: Place masonry joint reinforcement in first and second horizontal joints above and below openings greater than 1'-0" wide, extending reinforcement at least 16" beyond each side of opening.
4. End Laps: Lap joint reinforcement ends a minimum of 6", placing a cross wire of each piece within the lap.
5. Intersections and Corners: Use only preformed welded units at corners and intersections, extending at least 18" each way; do not lap straight units at "T" intersections nor cut and bend joint reinforcement at "L" corners.
6. Mortar Coverage: Fully embed longitudinal side rods in mortar for their entire length: minimum cover of 5/8" on exterior side of walls after tooling and 1/2" at other locations.
7. Control And Expansion Joints: Break reinforcement at control joints. Do not bridge control or expansion joints with reinforcing except at wall openings.

3.8 BAR REINFORCED MASONRY

A. Concrete Block Placement:

1. Set block webs in full mortar beds to maintain leak-free cells. Fill end joints to the full depth of face shell thickness.
2. Maintain grout spaces free of excess mortar and debris.

B. Bond Beam Reinforcement:

1. Make bond beams continuous. Step bond beams as required in field.
2. Reinforce bond beam with two No. 4 bars placed 1" from bottom web when not indicated otherwise.
3. Place reinforcement in accordance with ACI 315. Return bars around corners a minimum of 8". Do not use defective bars or bars bent incorrectly.
4. Lap the splices to provide at least a Class A splice per ACI 318.

C. Grouting:

1. Remove loose rust and scale from reinforcing bars and remove rust, ice, water and dirt from cavity bottoms before pouring grout.
2. Grout walls using low-lift grouting technique in lifts not more than 5ft high, allowing at least 24 hours to pass between successive lifts.
3. Place grout continuously; do not interrupt pouring of grout for more than one hour. Do not disturb reinforcement while placing grout.
4. Consolidate grout 5 to 10 minutes after pouring. Puddle and rod the grout.

3.9 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.10 LINTELS

- A. Install steel lintels furnished under Section 055000 "Metal Fabrications".
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.11 FLASHING

- A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.
- B. Locations: Install thru-wall flashings at the following masonry locations, whether shown or not:
 1. At base of exterior masonry walls.
 2. Over all exterior lintels.
- C. Thru-Wall Flashing Fabrication: Form typical thru-wall flashings by adhering self-adhesive flashing membrane to a stainless steel edge drip, adhering membrane all across the top of the sheet metal. Trim membrane at edge of metal drip.
 1. Install the metal edge drip to make continuous runs. Make "dollar" lap joints, overlapping joints 6"; or lap the metal joints 1" and fill with the mastic used to set the edge drip. Trim the metal length to match the width of the flashing except at lintels, where the length of metal shall be cut to match the width of the door/window opening.
- D. Thru-Wall Flashing Installation:
 1. Comply with flashing membrane manufacturer's temperature limitations.
 2. Install in one piece to the extent practicable. Lap flashing 6" at joints and seal joint edges continuously.
 3. Lintel Flashings: Extend flashings past ends of lintel and fold flashing up into first head joints beyond end of lintel to form a positive end dam.
 4. Step Flashings: At the end of each section of flashing, fold flashing at least 1" up into a head joint so as to form a positive end dam.

3.12 MORTAR JOINT FINISHING

- A. Flush Joints: Strike interior wall joints flush where masonry is to be covered by other materials.
- B. Tooled Joints: Tool all joints not concealed by other work.
 1. At time of laying, strike masonry joints flush.

2. When mortar in joints becomes thumbprint hard, tool to a hard, concave finish, using sled-type jointer at least 16" long, with diameter 1/8" to 1/4" larger than joint.
3. Jointing tools shall be same diameter for each type of masonry.

C. Caulked Joints: Rake out joints 1/2" deep where caulking is required.

3.13 FITTING AND PATCHING

- A. Do all cutting and patching of masonry for the Work required by other trades.
- B. Replace damaged masonry. Spot patching of exposed units with mortar must be inconspicuous.
- C. Cut and fit for chases, pipes, conduits, sleeves, etc. Cooperate with other trades to provide correct size, shape and location. Avoid cutting and patching to accommodate work under other Sections by coordinating masonry work with other trades.

3.14 REPAIR AND FINAL POINTING

- A. At completion of the work, cut out and repoint all holes, cracks and defective joints, using mortar colored to match after it dries. Cut out hardened mortar to a depth of 1/2" and dampen the hardened mortar before patching.
- B. Retool and reclean joint patches to match adjacent work. Leave exterior walls watertight.

3.15 CLEANING

- A. Remove excess mortar and droppings as work progresses, avoiding stains and smears. Do not allow excess mortar lumps or smears to harden on finish surfaces.
- B. Clean the interior masonry before application of floor finishes is started.
- C. Concrete Block: When concrete masonry unit placement is complete, rub masonry with carborundum brick to remove all sharp edges and then clean work with stiff bristle brushes, or other approved method, removing loose granules, building dust, etc. Comply with recommendations of NCMA TEK Bulletin 28.

3.16 ANTI-GRAFFITI COATING

- A. Clean all brick surfaces prior to installing the coating.
- B. Install (1) coat of the coating per manufacturer's recommended application rates.
- C. The owner may purposely test an area by applying graffiti to the wall to verify appropriate coverage.

3.17 PROTECTION

- A. At day's end and when precipitation is anticipated, cover tops of unfinished walls with plastic sheeting to prevent moisture infiltration.
- B. Protect exposed external corners that may be damaged by construction activities.
- C. Brace and shore masonry constructions until they are able to withstand ambient wind loads.
- D. Do not allow uniform structural loads to be applied to unbraced or unshored masonry for at least 12 hours after construction. Protect from concentrated loads for at least 3 days after construction.

3.18 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

DIVISION 05 – METALS
SECTION 051200
STRUCTURAL STEEL 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.
- B. SUMMARY
 - 1. Structural steel.
 - 2. Field-installed shear connectors.
 - 3. Grout.
- C. Related Requirements:
 - 1. Section 033000 "Cast-In-Place Concrete" for concrete foundations.
 - 2. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
 - 3. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
 - 4. Section 099113 "Painting" for surface-preparation and priming requirements.

1.2 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

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 anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 2. Include embedment Drawings.
 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
- C. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Mill test reports for structural steel, including chemical and physical properties.
- C. Product Test Reports: For the following:
1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 4. Shear stud connectors.
 5. Shop primers.
 6. Nonshrink grout.
- D. Survey of existing conditions.
- E. Source quality-control reports.
- F. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
 2. AISC 360.
 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
- B. Moment Connections: Type PR, partially restrained.
- C. Construction: Moment frame.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992/A 992M.
- B. Channels, Angles: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).
- E. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade C, structural tubing.
- F. Corrosion-Resisting, Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.
- G. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
 - 1. Weight Class: As noted on drawings.
 - 2. Finish: Black except where indicated to be galvanized.

- H. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.
- I. Steel Forgings: ASTM A 668/A 668M.
- J. Welding Electrodes: As noted on drawings.

2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip or mechanically deposited zinc coating.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain.
- E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- F. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
 - 1. Configuration: Straight and Hooked.
 - 2. Nuts: ASTM A 563 (ASTM A 563M) -hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 5. Finish: Plain.
- G. Headed Anchor Rods: **ASTM F 1554, Grade 36.**
 - 1. Nuts: ASTM A 563 (ASTM A 563M) hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 4. Finish: Plain.
- H. Threaded Rods: **ASTM A 36/A 36M.**

1. Nuts: ASTM A 563 (ASTM A 563M) hex carbon steel.
 2. Washers: ASTM A 36/A 36M carbon steel.
 3. Finish: Plain.
- I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
 - J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

2.4 PRIMER

- A. Primer: Comply with Section 099113 "Painting"
- B. Primer: SSPC-Paint 25, Type I, zinc oxide, alkyd, linseed oil primer.
- C. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- D. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.5 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
 1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.
- H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.

2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 - 2. Surfaces to be field welded.
 - 3. Surfaces of high-strength bolted, slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 5. Galvanized surfaces.
 - 6. Surfaces enclosed in interior construction.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."

3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
 5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
 6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
 8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
 9. SSPC-SP 8, "Pickling."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
 2. Galvanize lintels attached to structural-steel frame and located in exterior walls.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Bolted Connections: Inspect and test shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
1. Liquid Penetrant Inspection: ASTM E 165.
 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 3. Ultrasonic Inspection: ASTM E 164.
 4. Radiographic Inspection: ASTM E 94.

- D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
 - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates Bearing Plates and Leveling 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. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. 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.

- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Verify structural-steel materials and inspect steel frame joint details.
 - 2. Verify weld materials and inspect welds.
 - 3. Verify connection materials and inspect high-strength bolted connections.

- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Painting."

END OF SECTION 051200

DIVISION 05 – METALS
SECTION 052100
STEEL JOIST 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. K-series steel joists.
- 2. Joist accessories.

B. Related Requirements:

- 1. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
- 2. Section 051200 "Structural Steel Framing" for joist bearing.
- 3. Section 055000 "Metal Fabrications" for bearing plates on ledger angle.

1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

- 1. Include layout, designation, number, type, location, and spacing of joists.
- 2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
- 3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Welding certificates.
- C. Manufacturer certificates.

D. Mill Certificates: For each type of bolt.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
 - 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
 - 1. Design special joists to withstand design loads with live-load deflections no greater than the following:
 - a. Roof Joists: As noted on drawings.

2.2 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
 - 1. Joist Type: K-series steel joists.
- B. Provide holes in chord members for connecting and securing other construction to joists. No connecting and/or securing other construction to bottom chords unless specifically noted on drawings.
- C. Camber joists according to SJI's "Specifications."
- D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 PRIMERS

- A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.4 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates from ASTM A 36/A 36M steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint
- C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."
- D. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
 - 1. Finish: Plain, uncoated.
- E. Welding Electrodes: Comply with AWS standards.
- F. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.

- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications, joist manufacturer's written recommendations, and requirements in this Section."
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
- C. Field weld joists to supporting steel bearing plates. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using carbon-steel bolts.
- E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect both field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
- C. Visually inspect bolted connections.
- D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
- E. Perform additional testing to determine compliance of corrected Work with specified requirements.

3.4 PROTECTION

- A. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Painting."
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 052100

DIVISION 05 – METALS

SECTION 053100 **STEEL DECKING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal roof deck.
2. Accessories and closures.
3. Fabrication of openings in metal deck not shown on Drawings but required by other trades.
4. Reinforcement of small openings in metal deck

B. Related Requirements:

1. Section 052100 "Steel Joist Framing" for deck bearing.
2. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

- B. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 ROOF DECK

- A. Acceptable Manufacturers:
 - 1. Bowman/E.G. Smith, Div. Cyclops Corp.
 - 2. Epic Metals Corp.
 - 3. Roll Form Products, Inc.
 - 4. United Steel Decking, Inc.
 - 5. Vulcraft/Div. Nucor Corp.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
 - 1. Steel for Painted Metal Deck Units: ASTM A 611, Grade C., shop primed with manufacturer's standard baked-on, rust-inhibitive primer; manufacturer's standard color.
 - 2. Deck Profile: As indicated on drawings.
 - 3. Profile Depth: As indicated on drawings.
 - 4. Design Uncoated-Steel Thickness: As indicated on drawings.
 - 5. Span Condition: Three span.
 - 6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch minimum thick, with factory-punched hole of 3/8-inch minimum diameter.
- G. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
 - 1. Weld Diameter: 5/8 inch, nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter, and as indicated on drawings, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches, and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum.
- D. Miscellaneous Roof-Deck Accessories: Install finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.

- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 PROTECTION

- A. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Painting."
- B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

PART 4 - END OF SECTION 053100

DIVISION 05 – METALS
SECTION 054000
COLD FORMED 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.
- B. SUMMARY
 - 1. Cold formed metal framing and accessories.
- C. Related Requirements:
 - 1. Section 042000 "Unit Masonry" for CMU wall backing.
 - 2. Section 051200 "Structural Steel Framing" for structural steel framing.
 - 3. Section 061000 "Carpentry Work" for gypsum board sheathing.

1.2 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.

1.3 SUBMITTALS

- A. Product Data: Provide shop drawings prepared by cold-formed metal framing manufacturer. Submit manufacturer's data for all steel stud framing items required, showing pertinent features.
- B. Shop Drawings: Submit details of construction for Architect's review. Include design assumptions and calculations for loads and stresses.
- C. Shop drawings shall be sealed by a Licensed Structural Engineer in the State of Illinois.

1.4 QUALITY ASSURANCE

- A. Fabricator's Qualifications: Minimum of 5 years' satisfactory experience producing items of like quality and type.

B. Component and System Design:

1. Design wall framing to the requirements of 2009 IBC, based on a uniformly distributed wind load of 30 psf, positive and negative pressure, with maximum allowable deflection of 1/600 span. When heads of studs will not be completely restrained, as at some deflection heads, do not use manufacturer's load tables but select stud size and gauge based on calculation of actual deflection resulting from the less-than-ideal stability of the top of the stud. Include for concentrated axial loads created by window weights.
2. Compute structural properties of studs in accordance with AISI "Specifications for the Design of Cold-Form Steel Structural Members" and AWCI (Association of Wall and Ceiling Industries) requirements, the more stringent requirement governing in case of differences.
3. Design the wall system to accommodate seasonal or cyclical day/night temperature variations without noise, damage, failure of joint seals, undue stress on fasteners, or other detrimental effects.
4. Design the system to accommodate construction tolerances and deflection of building structures.

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

1. Qualify welding processes and welding operators in accordance with the AWS "Standard Qualifications Procedure."
2. Submit to the Architect, upon request, current certifications that welders employed on the site have passed all required AWS qualification tests within the previous 12 months.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect and store metal framing units from rusting and damage in accordance with A.I.S.I.'s "Code of Standard Practice".

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acceptable Manufacturer: One of the following:

1. Aegis Metal Framing.
2. ClarkDietrich Industries, Inc.
3. MarinoWare.

2.2 Studs: Sheet Steel per ASTM A 653, and A 1003/A 1003M gauges as shown on Drawings but not less than 18-gauge, galvanized finish minimum G-60 coating.

1. Steel Grade:
 - a. 33-ksi minimum for 18 ga. and lighted members.
 - b. 50-ksi for 16 ga and heavier members.

2. Minimum uncoated steel thicknesses:

- a. 18-gauge .0428" (yellow)
- b. 16-gauge .0538" (green)
- c. 14-gauge .0677" (orange)
- d. 12-gauge .0966" (red)

- B. Track and Accessories: Include all track and sheet metal accessories required, fabricated from matching metal.
- C. Screw Fasteners: Cadmium coated.

PART 3 - EXECUTION

3.1 FRAMING

- A. General: Erect metal framing per the requirements of ASTM C 1007.
- B. Studs, track, bracing, etc. shall be used and erected as recommended by manufacturers. Connections shall not induce distortions into the framing.
- C. Runner Tracks: Install continuous tracks, straight and true, accurately aligned to the layout at base and at tops of studs. Anchor track at corners and ends.
- D. Set studs plumb, except as indicated otherwise, not more than 16" o.c. and not more than 2" from abutting walls. In each line of studs, face flanges all in the same direction. Erect studs one-piece full length; splicing not permitted.
- E. Secure studs to runners, top and bottom, at both inside and outside flanges, by either welding or screwing with the equivalent of 2 Type "S" screws.
- F. Bridging: Install between studs as required to prevent stud rotation.
- G. Supplementary Framing: Install blocking and bracing to support other work requiring attachment to the framing system. Where type of supplementary support is not otherwise indicated, comply with the stud manufacturer's recommendations and industry standards, considering the weight or loading resulting from the item supported.
- H. Junctures With Masonry Structures: Provide compressible filler strip at least 1/2" thick between top runners and structure above. Where studs abut masonry or concrete, install 1/2" thick compressible filler strip full height of stud.
- I. Welding: Perform welding, including tack welds, in accordance with ANSI/AWS D1.1.
 - 1. Protect members from damage caused by welding. Provide non-combustible shield during welding operations.
 - 2. Touch-up welds on hot-dip galvanized items with zinc-rich paint after cleaning joint of welding residues.

3.2 END OF SECTION 054000

DIVISION 05 – METALS
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. Items fabricated from iron and steel shapes, plates, bars, strips, tubes and pipes which are not part of the steel structural framing or other metal systems in other Sections of the Specifications. The items of this Section include but are not necessarily limited to the following:
 - a. Steel lintels and miscellaneous framing members.
 - b. Metal hand rails and guard rails.
 - c. Dumpster enclosure steel.
2. Anchorages of type appropriate to the supporting structure and as required to provide a sturdy installation resistant to all reasonable loads.
3. Cutting, reinforcing, drilling and tapping as required to erect the work and to fit it with work provided under other Sections of the Specifications.

- B. Related Requirements:

1. Section 033000 "Cast-In-Place Concrete" for hand rail set in exterior concrete slabs.
2. Section 042000 "Unit Masonry" for hand rail attachment CMU walls.
3. Section 053100 "Steel Decking" for roof deck openings.
4. Section 099113 "Painting" Finish painting.

1.3 COORDINATION

- A. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorage that are to be embedded in existing masonry. Deliver such items to Project site in time for installation.

1.4 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for:
 - 1. Loose steel lintels.
 - 2. Miscellaneous steel framing members.
 - 3. Metal hand rails.

QUALITY ASSURANCE

- B. Field Measurements: Take prior to preparation of Shop Drawings and fabrication, where possible. Take measurements in time, so as to avoid delaying job progress. Allow for trimming and fitting.
- C. Qualifications of Welders: Welding operators for shop fabrication shall be qualified, in accordance with AWS "Standard Qualifications Procedure."
- D. Codes and Standards: Comply with the following unless otherwise indicated:
 - 1. AISI, Steel Products Manual, Stainless and Heat Resisting Steel.
 - 2. ANSI A58.1, Minimum Design Loads in Buildings and Other Structures.
 - 3. AWS D1.1 "Structural Welding Code."
 - 4. OSHA: 1910.27 and 1926.1053.
 - 5. All applicable building codes having jurisdiction.
 - 6. Americans with Disabilities Architectural Guidelines.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: For fabrication of miscellaneous metal work that will be exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names and roughness.
 - 1. Steel Plates, Shapes, and Bars: ASTM A 36.
 - 2. Steel Tubing: Hot-formed, welded or seamless, ASTM A 501.
 - 3. Galvanized Carbon Steel Sheets: ASTM A 526, with ASTM A 525, G 90 zinc coating.
 - 4. Steel Sheets In Assemblies To Be Galvanized: ASTM A 569 or A 570.
 - 5. Steel Pipe: ASTM A 53; type as selected; Grade A; standard weight (Schedule 40), unless otherwise indicated. Exterior pipe shall be galvanized.
 - 6. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.

- B. Anchor Bolts: Unfinished threaded fasteners per ASTM A 307, nonheaded type unless otherwise indicated
- C. Rail Post Sleeve Forms: "EZ Sleeve" as produced by Auciello Iron Works, Inc., Hudson, Massachusetts, tel. 508-568-8382.
 - 1. Non-Shrink Grout: Pre-mixed, non-metallic, non-corrosive, non-staining grout having a minimum compressive strength of 7, "Masterflow" Master Builder.
 - 2. "Five Star Grout" by U.S. Grout Corp.
 - 3. "Upcon" by Upco Chem. Div. USM Corp.
 - 4. "588 Grout" by W.R. Meadows.
 - 5. "Multi Purpose Grout" by Symons Corp.
- D. Metal Primer Paint: Comply with VOC limit requirements of Green Seal Standard GS-11.
- E. Touch-Up Paint For Galvanized Surfaces: Zinc-rich, inorganic cold galvanizing compound having a minimum of 80% zinc dust in the dry film, such as Carboline Carbo Zinc or Carbo Weld; or Z.R.C.

2.2 SHOP FINISH

- A. Shop Painting: One-coat shop paint in accordance with Society for Protective Coatings (SSPC) System Guide No. 7.00, except apply 2 coats of paint to surfaces that will be inaccessible after assembly or erection.
 - 1. Extent: Shop paint all miscellaneous and ornamental metal work, except surfaces and edges to be field welded, and galvanized surfaces, unless otherwise specified.
 - 2. Surface Preparation: Remove scale, rust, grease, oils and other deleterious materials before applying shop coat of paint.
- B. Galvanizing:
 - 1. Coating Weights: Items indicated to be galvanized shall be hot-dip galvanized according to the following specifications:
 - a. Assembled steel products: ASTM A 386, 1.25 oz./sq. ft.
 - b. Structural steel shapes: ASTM A 123, 1.25 oz./sq. ft.
 - c. Steel hardware: ASTM A 153, 1.25 oz./sq. ft.
 - 2. Fabrication: Galvanize only after fabrication. Drilling, welding and other fabrication, except bolting, shall be completed before galvanizing. Welds shall be free of slag and residue.
 - 3. Quenching: Galvanized items shall be passivated in a water quench.
 - 4. Galvanizer's Affidavit: Galvanizer shall inspect galvanizing after dipping and submit notarized affidavit certifying compliance with these specifications.
 - 5. Grade Stamp: Stamp each item, indicating ASTM designation and weight of coating.

2.3 FABRICATION – GENERAL

- A. Sizes and Thicknesses: As shown, or, if not shown, as required to produce adequate strength and durability in the finished products. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
- B. Preassembly in Shop: Preassemble the items in the shop to greatest extent possible, to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Dissimilar Metals: Wherever dissimilar metals come into contact, insert lead washers, spacers or gaskets between them to provide electrolytic insulation.
- D. Workmanship: Form exposed work true to line and level, with accurate angles and surfaces and straight, sharp smooth edges.
- E. Welds: Weld corners and seams continuously and in accordance with recommendations of American Welding Society. Grind exposed welds smooth and flush.
- F. Items to be Galvanized: Complete drilling, welding and other fabrication, except bolting, before galvanizing. Clean welds of slag and residue. Provide vent holes as required.

2.4 FABRICATION SPECIFICS

- A. Miscellaneous Steel Beams and Framing: Provide structural framing members standard and galvanized as noted on drawings which are not a part of Structural Steel.
- B. Loose Steel Lintels:
 - 1. General: Furnish loose structural steel lintels for installation over openings where shown or called for on drawings.
 - 2. Finish: Steel and galvanized steel where noted on drawings.
 - 3. Composite Constructions: Weld adjoining members together to form single unit unless indicated otherwise.
 - 4. Bearing: Provide for at least 8" bearing at each side of openings unless opening is less than 6'-0" wide, in which case, provide at least 6" of bearing at each side.
- C. Railings:
 - 1. Nominal 1-1/4" steel pipe, except as indicated otherwise on Drawings. Use standard weight and heavy weight pipe as required to withstand loads established by all applicable codes. Design the connections to withstand all uniform and concentrated loads required by codes.
 - 2. Ends: Wall railings shall have bent ends returning to wall; otherwise, close the ends with welded-on plugs.
 - 3. Wall Brackets: Secure handrails to wall with malleable iron brackets at not over 8 ft centers. Brackets shall be sized to provide 1-1/2" clearance between rail and face of wall.

4. Post Receivers:
 - a. Core the cured concrete to receive the pipe posts or provide pipe sleeve made of same material and finish as pipe rail
5. Flange Coverings: Provide slip flange fittings to cover bolted-on rail end connections at walls and sleeves at floors.
6. Finish:
 - a. Interior Use: Black steel with a rust inhibiting prime coat.
 - b. Exterior Use: Galvanized steel (field painted).

2.5 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls.
- B. Post-Installed Anchors: Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy stainless-steel bolts, and nut.

2.6 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
 2. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Contractor shall verify all opening sizes in field prior to developing shop drawings.
- B. 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.
- C. 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.
- D. 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.
 5. All contacts with steel angles shall be welded.
- E. 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.

3.2 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 (0.05-mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint.
- 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

DIVISION 06 – WOOD, PLASTIC & COMPOSITES

SECTION 061000
CARPENTRY WORK

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. Wood blocking and nailers.
- B. Gypsum board sheathing.
- C. Insulated wall panel system.
- D. Wall insulation.
- E. Installation of wood door and door hardware.
- F. Related Requirements:
 - 1. Section 081416 "Flush Wood Doors" for wood door to be installed.
 - 2. Section 087110 "Door Hardware" for finish hardware to be installed in wood door installation.
 - 3. Section 092900 "Gypsum Board System" for soffits.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Submit manufacturer's product data for premanufactured items.
- B. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- C. Evaluation Reports: For Wood-preservative-treated wood, from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Measurements: Before proceeding with millwork to be fitted to other construction, obtain field measurements and verify dimensions and Shop Drawing details as required for accurate fit.
- B. Workmen: Use only tradesmen experienced in the fabrication and installation of millwork.

PART 2 - PRODUCTS

2.1 WOOD BASED MATERIALS

- A. Adhesive: Waterproof; use type recommended by millwork manufacturer. Products made with urea-formaldehyde or melamine-formaldehyde must comply with HPMMA Standard FTM 2 for emissions.

2.2 EXTERIOR WALL SHEATHING

- A. Gypsum Sheathing: The Drawings are based on "Dens-Glass Gold" by Georgia-Pacific, 1/2" thick, manufactured per ASTM C 1177, with glass mat on faces and long edges laminated to silicone treated gypsum core. "Fiberock Sheathing" by USG, 5/8" thick, may also be used or Owner approved equal during the bidding phase.

2.3 NAIL BASE INSULATED WALL PANEL SYSTEM

- A. Wall Panel: Hunter Panels Xci Ply by Hunter Panels or Owner approved equal during the bidding phase. Material shall:
 - 1. 5/8" fire rated treated plywood or FSC certified fire treated plywood.
 - 2. Thermal Values:
 - a. Total Thickness (Includes plywood & rigid insulation): 2.1".
 - b. R value: 9.6.

2.4 WALL INSULATION

- A. Batt Insulation:
 - 1. Acceptable Manufacturers:
 - a. Owens-Corning.
 - b. Guardian Fiberglass.
 - c. CertainTeed.
 - d. USG.
 - e. Johns Manville.
 - f. Glass or other inorganic fibers and resinous binders formed into unfaced flexible blankets of thicknesses indicated conforming to ASTM C 665, Type I, with density not less than 0.5 pcf. Thickness: full depth of stud.

2.5 FASTENERS/SUPPORT FRAMING

- A. Nails: Ring-shank or rough coated finish, size and type to suit application.
- B. Screws: Plain steel; wood or sheet metal shank; flat, countersunk Phillips or square drive head.
- C. Bolts, Nuts, Washers: Size and type to suit application; unfinished in concealed location.

2.6 WOOD PRODUCTS

- A. General:
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. Dress lumber, S4S, unless otherwise indicated.
 - 3. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.7 SHOP FABRICATION

- A. General:
 - 1. Adhesives: Use waterproof, resorcinol-formaldehyde type adhesive. Products made with urea-formaldehyde or melamine-formaldehyde must comply with HPMA Standard FTM 2 for emissions.
 - 2. Loose Joints: Locate loose joints so as to render them as inconspicuous as possible in the finished work.

2.8 WOOD BLOCKING AND NAILERS

- A. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- B. 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

2.9 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is pressure-preservative treated 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: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

2.10 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction. Use Category UC3b for exterior construction.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all rough carpentry unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wood Blocking/Nailer:
 - 1. 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.
 - 2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
 - 3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.
- B. Flush Wood Door and Finish Hardware:
 - 1. Install flush wood door on hollow metal door frame.
 - 2. Install finish hardware on flush wood door and attach to hollow metal door frame.
- C. General:
 - 1. Setting: Secure work to grounds and blocking as required, holding to correct surfaces, lines and levels. Make finished work flat, plumb, and true. Install items tight to adjoining surfaces except as approved otherwise. Cope and scribe for tight fits.
 - 2. Fastening: Conceal fastenings; where not possible, locate them in inconspicuous places. Where nailing is permitted through woodwork face, conceal nail heads. Do not nail adjacent woodwork to paneling.
 - 3. Loose Joints: Locate loose joints to render them as inconspicuous as possible in finish work. Make joints in interior work with rail bolts that can be pulled up tight to form perfectly flush joints.

4. Expansion Joints: Install joints to permit sections to expand and contract without buckling, warping or causing other conditions that will detract from appearance and durability.
5. Miter external corner of flat horizontal members; house internal corners. Miter external corners of molded members; cope internal corners. Glue mitered corners; secure with corrugated metal fasteners.
6. At substrate irregularities apply colored sealant at such spaces and tool sealant to a straight line along millwork edge.
7. Thoroughly sand finished wood items smooth. Touch up edges and make smooth.
8. Coat cut surfaces of preservative treated wood after cutting, with a heavy brush coating of the same preservative

3.2 EXTERIOR WALL SHEATHING

- A. General: Install gypsum sheathing per manufacturer's instructions. Apply boards horizontally with gold side out, in as long lengths as practicable to minimize joints. The top of every board installed shall be wrapped with glass mat.
- B. Screwing: Install with screws 8" o.c. along edges and in the field, at least 3/8" away from edges. Drive screw heads FLUSH with surface; do NOT SINK screw heads. Adjust screw guns accordingly.
- C. Joints: Make joints tight, without forcing, and offset the end joints from course to course. End joints shall occur only over framing. Hold joints at least 12" away from edges of openings.
- D. Taping: Cover exposed edges and joints with tape, using fiberglass tape well embedded in specified joint sealant. Lap tape at intersections; do not leave any tape edges loose

3.3 NAIL BASE INSULATED WALL PANEL SYSTEM

- A. Install system in accordance with manufacturer's latest printed instructions and as detailed on drawings.

3.4 WALL INSULATION INSTALLATION

- A. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to the project conditions, consult the manufacturer's technical representative for specific recommendations before proceeding with the work.
- B. Extend insulation full thickness shown over entire surface to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation.
- C. Apply a single layer of insulation of the required thickness unless otherwise shown or required to make up the total thickness.
- D. Do not obstruct ventilation spaces. Provide batts of appropriate width to fit in spaces tightly.
- E. Insulation shall fill all voids as shown on drawings.
- F. Penetrations where ducts or structural framing cut insulation shall be stuffed all around with insulation

3.5 FINISH HARDWARE FOR DOORS

- A. Receive, store, protect and install finish hardware for wood and hollow metal doors on entire project as furnished by finish hardware supplier under Section 087100 - Finish Hardware. Install according to requirements specified in Section 087100.
- B. Adjust, and protect from injury all installed hardware. Cover door knobs and levers with heavy cloth until project acceptance.
- C. Deliver keys to Owner at completion and acceptance of work.

3.6 ADJUST AND CLEAN

- A. Repair damaged or defective work to the satisfaction of the Architect.
- B. Adjust and lubricate hardware for proper operation.
- C. Clean exposed interior surfaces.

3.7 PROTECTION

- A. Protect installed finish carpentry from damage by other trades until Owner's acceptance of the work.

END OF SECTION 061000

DIVISION 07 – THERMAL & MOISTURE PROTECTION

SECTION 072726

FLUID APPLIED MEMBRANE AIR BARRIERS

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 fluid-applied, vapor-retarding membrane air barriers.
- B. Related Requirements:
 - 1. Section 042000 "Unit Masonry" for CMU substrate.
 - 2. Section 061000 "Carpentry Work" for wall sheathings and weather barriers

1.3 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.

- B. Shop Drawings: For air-barrier assemblies.
 - 1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 2. Include details of interfaces with other materials that form part of air barrier.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by the Installer, who work on Project.
- B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
- C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 - 1. Build integrated mockups of exterior wall assembly as shown on Drawings, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
 - b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
 - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
 - 1. Protect substrates from environmental conditions that affect air-barrier performance.
 - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.3 VAPOR-RETARDING MEMBRANE AIR BARRIER

- A. Fluid-Applied, Vapor-Retarding Membrane Air Barrier: Elastomeric, modified bituminous membrane.
 - 1. Elastomeric, Modified Bituminous Membrane:
 - a. Barriseal S by Carlisle Coatings & Waterproofing Inc.
 - b. Air-Bloc 06 WB by Henry Company.
 - c. Textroflash Liquid by Holmann & Barnard, Inc.
 - d. Air-Shield LM by W.R. Meadows.
 - e. ExoAir 120SP/R by Tremco Inc.
 - f. Vapor Seal by STO Corp.
 - g. Prosoco R-Guard VB by Prosoco Inc.
 - h. Polyguard Air Lok Flex by Polyguard Products, Inc.
 - i. or Owner approved equal during the bidding phase.
 - 2. Physical and Performance Properties:

- a. Vapor Permeance: Maximum 0.1 perm (5.8 ng/Pa x s x sq. m); ASTM E 96/E 96M.

2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.
- B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.
- C. Counterflashing Strip: Modified bituminous, 40-mil- (1.0-mm-) thick, self-adhering sheet consisting of 32 mils (0.8 mm) of rubberized asphalt laminated to an 8-mil- (0.2-mm-) thick, cross-laminated polyethylene film with release liner backing.
- D. Butyl Strip: Vapor retarding, 30 to 40 mils (0.76 to 1.0 mm) thick, self-adhering; polyethylene-film-reinforced top surface laminated to layer of butyl adhesive with release liner backing.
- E. (0.1-mm-) thick polyethylene film with release liner backing.
- F. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.
- G. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- H. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- I. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0187 inch (0.5 mm) thick, and Series 300 stainless-steel fasteners.
- J. Modified Bituminous Transition Strip: Vapor retarding, 40 mils (1.0 mm) thick, smooth surfaced, self-adhering; consisting of 36 mils (0.9 mm) of rubberized asphalt laminated to a 4-mil- (0.1-mm-) thick polyethylene film with release liner backing.
- K. Adhesive-Coated Transition Strip: Vapor-permeable, 17-mil- (0.43-mm-) thick, self-adhering strip consisting of an adhesive coating over a permeable laminate with a permeance value of 37 perms (2145 ng/Pa x s x sq. m).
- L. Elastomeric Flashing Sheet: ASTM D 2000, minimum 50- to 65-mil- (1.3- to 1.6-mm-) thick, cured sheet neoprene with manufacturer-recommended contact adhesives and lap sealant with stainless-steel termination bars and fasteners.
- M. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.
 - 1. Product: Subject to compliance with requirements, provide one of the following:
 - a. 123 Silicone Seal by Dow Corning Corp.
 - b. US11000 UltraSpan by Momentive Performance Materials.

- c. Sil-Span by Pecora Corp.
 - d. Spectrem Simple Seal by Tremco Inc.
- N. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 079200 "Joint Sealants."
- O. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
 - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
 - 1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of 3 inches (75 mm) along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.

3.4 TRANSITION STRIP INSTALLATION

- A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip, adhesive-coated transition strip, elastomeric flashing sheet or preformed silicone-sealant extrusion so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.
 - 1. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.
 - 2. Adhesive-Coated Transition Strip: Roll firmly to enhance adhesion.
 - 3. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches (150 mm) o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
 - 4. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

- G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- H. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, modified bituminous or counterflashing strip.
- I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

- A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.
 - 1. Apply primer to substrates at required rate and allow it to dry.
 - 2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
 - 1. Vapor-Retarding Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil (1.0-mm) dry film thickness, applied in two equal coats.
- C. Apply strip and transition strip a minimum of 1 inch (25 mm) onto cured air-barrier material] or strip and transition strip over cured air-barrier material overlapping 3 inches (75 mm) onto each surface according to air-barrier manufacturer's written instructions.
- D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.
- F. Remove masking materials after installation.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections if they require.
- B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 2. Continuous structural support of air-barrier system has been provided.
 3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
 4. Site conditions for application temperature and dryness of substrates have been maintained.
 5. Maximum exposure time of materials to UV deterioration has not been exceeded.
 6. Surfaces have been primed, if applicable.
 7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 8. Termination mastic has been applied on cut edges.
 9. Strips and transition strips have been firmly adhered to substrate.
 10. Compatible materials have been used.
 11. Transitions at changes in direction and structural support at gaps have been provided.
 12. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 13. All penetrations have been sealed.
- C. Tests: As determined by Owner's testing agency and paid for by the Owner.
- D. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.7 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION 072726

DIVISION 07 – THERMAL & MOISTURE PROTECTION

SECTION 074213
FORMED METAL WALL PANELS

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 exterior metal wall panel system,
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for insulated wall panel system.

1.3 SYSTEM DESCRIPTION

- A. Panel's exposed finishes shall perform according to AAMA 2605-98; exposed anodized aluminum according to AAMA 611-98.
- B. Panel Composite Assembly: Conform to ASTM E84, Flame Spread Resistance, Class A.
- C. Panel composite assembly shall pass Modified ASTM E108, External Flame Resistance.
- D. Panel composite assembly shall pass UBC 26-3, Fire Standard For Interior Applications.
- E. Panel bond integrity shall have a minimum peel strength of 34.5 in-lbs/in when tested according to ASTM D1781.
- F. Design wall system to withstand a positive and negative wind load pressure acting inward and outward normal to the plane of the wall to meet the requirements of the 2009 International Building Code.
- G. Make adequate provisions in the wall system for thermal expansion and contraction of the component parts and fastening of the system to prevent harmful damage caused by buckling, opening of joints, contraction and expansion due to accumulation of dead loads and variations of live loads, in accordance with ASTM E72, Strength Tests For Panels For Building Construction.
- H. Water Leakage: No water infiltration into the panel system under static pressure when tested in accordance with ASTM E331 at a differential of 10% of inward acting design load, 6.24 psf (.299 kPa) minimum, after 15 minutes.
- I. Air Leakage: Not more than 0.06 (cfm)/sf of wall area (.003 (L/s) m²), when tested at 1.57 psf (.075 kPa) in accordance with ASTM E283.

1.4 QUALITY ASSURANCE

- A. Take field measurements prior to preparation of shop drawings and fabrication, where possible. Take measurements in time, so as to avoid delaying job progress. Allow for trimming and fitting.
- B. Panel Manufacturer: Manufacturer shall have a minimum of ten (10) years experience in the manufacture of ACM/MCM and have ISO 9001:2000 Certification.
- C. Panel Installers: Installer shall be experienced in performing work of this section and be specialized in the installation of similar work required on this project.
- D. Field Measurements: When possible, measurements should be taken prior to the completion of shop manufacturing and assembly.
- E. Pre-Installation Meetings: Conduct pre-installation meetings to verify project requirements, substrate condition, installation instructions and warranty requirements.
- F. Source Limitations:
 - 1. Obtain each type of wall panel from single source from single manufacture.
 - 2. Installer: Pre-Qualified Company specializing in performing the work of this Section shall install the system in strict compliance with the written manufacturer's instruction.
- G. References:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM E84: Surface Burning Characteristics.
 - b. ASTM D1781: Climbing Drum Peel for Adhesives.
 - c. ASTM E108 (Modified): Standard Test Methods for Fire Tests of Roof Coverings.
 - d. ASTM E72: Strength Tests for Panels for Building Construction.
 - e. ASTM E331: Test for Water Penetration of Exterior Walls by Uniform Static Air Pressure Difference.
 - f. ASTM E283: Test Method for Rate of Air Leakage through Exterior Walls
 - 2. Architectural Aluminum Manufacturers' Association (AAMA):
 - a. AAMA 2605-98: Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
 - b. AAMA 611-98: Voluntary Specification for Anodized Architectural Aluminum.
 - 3. UBC26-3: Room Fire Test Standard for Interior of Foam Plastic Systems.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal wall panel and accessory.
- B. Shop Drawings:
 - 1. Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, corners, and accessories; and special details. Distinguish among factory, shop, and field-assembled work.
 - 2. Coordination Drawings: Elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Metal wall panels.
 - b. Wall-mounted items.
 - c. Penetration of wall by utilities.
- C. Samples: Samples for Verification: For type of exposed finish required, prepared on 6" x 6" sample of actual material.
- D. Maintenance Data: For metal wall panels to include in maintenance manuals.
- E. Preconstruction field adhesion test reports.
- F. Warranties: Sample of Manufacturers standard warranty.

1.6 WARRANTY

- A. Manufacturer's Warranty: Furnish panel manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to and not a limitation of other rights Owner may have under the Contract Documents.
- B. Panel Lamination Warranty: Five (5) years commencing on Date of Substantial Completion.
- C. Installing Contractor shall warranty the system for 2 years from substantial completion.
- D. Finish Warranty: Kynar 500®: Twenty (20) years.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package panels for protection during transportation and handling.
- B. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.
- C. Store covered with suitable weather tight and ventilated covering. Store panels to ensure dryness, with positive slope for drainage of water. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

PART 2 - PRODUCTS

2.1 ACCEPTABLE TYPES & MANUFACTURERS

- A. Metal Composite Material Wall Panel Systems: Provide factory-formed and assembled, metal composite material wall panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assembly components, panel stiffeners and accessories required for a watertight condition. Basis of Design - "Panel 20 - R (Reveal)" by Citadel or equal by Alucobond, Reynobond or Formabond Wall System or Owner approved equal during the bidding phase.

1. Materials:

a. Panel Composition:

- 1) Face Skin: .024" (minimum) prefinished smooth aluminum, in custom color as selected by Architect.
- 2) Core: .75" thermoset phenolic resin.
- 3) Back Skin: .024" primed smooth aluminum backer.
- 4) Panel Thickness: 1/8"

b. Panel Tolerances:

- 1) Thickness: $\pm 1/32$ ".
- 2) Length and Width: +0, -1/16".
- 3) Squareness: 1/64" per lineal foot.

c. Attachment System: R System.

d. Finish: Exposed finish of Kynar 500.

- 1) Custom color as selected by Architect.

e. Accessories:

- 1) Fasteners and moldings as required for panel system's design by panel system manufacturer. Fasteners shall be coated or stainless steel.
- 2) Weather Seals: Shall be Tremco® Spectrem® 2 or Dow Corning 795™, applied per the sealant manufacturer's instructions.

2.2 FABRICATION

- A. Panels shall be factory fabricated and finished by manufacturer. Comply with indicated profiles and with dimensions as detailed and noted on drawings.
- B. Form exposed work true to line and level, with accurate angles and surfaces and straight, sharp smooth edges.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine and verify substrate surfaces to receive composite metal panel system and associated work and condition which work will be installed.
- B. Maximum deviation from vertical and horizontal alignment of substrate shall be no more than 1/4" in 20'-0".
- C. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer. Starting work within a particular area will be construed as installer's acceptance of surface conditions.

3.2 COORDINATION

- A. Coordinate with other trades for any items which may be attached to or require penetrations to the panel.

3.3 INSTALLATION

- A. Erect panels level and true to intended plane.
- B. Anchor panels securely in place in accordance with manufacturer's/fabricator's approved Shop Drawings.
- C. Maximum deviation from vertical and horizontal alignment of erected panels shall be no more than 1/4" in 20'-0".
- D. Maximum deviation in panel flatness shall be 0.6% of the assembled units.
- E. Conform to panel manufacturer's instructions for attachment systems.
- F. Weather seal all joints as required using methods and materials as recommended by the panel manufacturer/fabricator.

3.4 CLEANING/REPAIR/REPLACEMENTS AND PROTECTION

- A. Weather seal all joints as required using methods and materials as recommended by the panel manufacturer/fabricator.
- B. Repair or replace damaged installed products.
- C. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.
- D. Remove and legally dispose of construction debris from project site.

END OF SECTION 079200

DIVISION 7 – THERMAL & MOISTURE PROTECTION

SECTION 075320
ADHERED TPO ROOFING

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. Fully adhered TPO sheet roofing systems.
 - 2. Board insulation.
 - 3. Gypsum board decking.
 - 4. Membrane roof flashings, base flashings and parapet flashings.
 - 5. Elastomeric flashing boots at pipe penetrations.
 - 6. Fasteners and adhesives.
 - 7. Sealants.
 - 8. Walkway pads.
 - 9. Expansion joints.
- B. Related Work Specified In Other Sections:
 - 1. Section 013300 "Submittal Procedures" for submittal of required items.
 - 3. Section 076200 "Sheet Metal Work" for new sheet metal work and roof trim.

1.3 QUALITY ASSURANCE

- A. Roofing Contractor: Illinois licensed, specializing for at least 5 years in the type of membrane system involved, who is approved by Architect and is certified/licensed by new roofing membrane system producer and who can furnish for this installation a foreman factory trained by the roof membrane system producer.
- B. Source of Supply: Membrane system materials shall be obtained from a single source of supply except as authorized otherwise by membrane producer.
- C. Standards of Installation: All components of roof system shall be furnished and installed to meet the wind 72 mph wind warranty.
- D. Scheduling and Coordination:
 - 1. Coordinate roofing installation with mechanical and electrical work associated with roof penetrations.
 - 2. No phased construction will be considered or approved.
- E. Wet and Damaged Materials: Shall not be installed.

1.4 SUBMITTALS

- A. Process all submittals as required in Section 01300 – Submittals.
- B. Product Data: Submit 3 copies of roofing materials producer's specifications, material characteristics and installation instructions for each product required including fasteners.
- C. Shop Drawings: Indicate:
 - 1. Outline of roof and dimensions.
 - 2. Typical and special details for flashings, roof curbs, penetrations, perimeter conditions, termination details, etc. Reference the locations of details on the roof outline.
 - 3. Number and mark of each factory prepared roofing sheet and flashing.
 - 4. Layout of tapered insulation saddle areas.
 - 5. Provide fastener locations and spacing for insulation installation.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packaging: Deliver materials to the job site in their original containers or packages, sealed, with legible labels intact, brand name, lot number, warning labels and reference standards clearly shown.
- B. Temperatures Prior to Use: Store materials in the dry and in accordance with membrane producer's instructions. Other than roof membrane, all materials furnished by membrane producer shall be stored between 60°F and 80°F. If exposed to lower temperatures, restore to 60 - 80°F prior to use.
- C. Warped or Broken Insulation Boards: Shall be removed from site.

1.6 JOB CONDITIONS

- A. Ambient Conditions: Do not apply adhesives below adhesive manufacturers' recommended ambient temperature ranges.
- B. Cold Weather: Follow membrane producer's special recommendations when cold weather retards free flow of adhesives and sealants. Do not apply adhesives below adhesive manufacturers' recommended ambient temperature ranges.
- C. Electrical Power: Furnish power for heat welders by way of portable generator(s) producing at least 30 amps per welder supplied or furnish power to 220V heat welders by way of #10 x 3 or greater power cords and boost the power with a step-up transformer when cord length exceeds 150 feet.
- D. Fire Prevention: Take every precaution to prevent fire.
 - 1. Maintain at least 2 portable fire extinguishers, rated 10-B:C-20 pounds, near area where adhesives are being used and train applicators in their proper use.
 - 2. Do not use open flames to heat adhesives. Allow solvents to air-dry.
 - 3. Use only grounded spray equipment.
- E. Coordinate with Owner to shut off or block vents which may allow solvents or adhesives vapors to be drawn inside the building.

1.7 WARRANTIES

- A. New Roofing: Shall be provided with a non-prorated, No-Dollar-Limit, full system warranty to Owner, including tapered insulation saddles, against leaks or defects of any kind due to faulty materials or workmanship, and to sustain a 72 mph maximum wind speed as follows:
 - 1. Roofing membrane system producer's 20 year warranty for materials and workmanship.
 - 2. Roofing Contractor's 2 year warranty for workmanship.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. System Fire Rating: Provide a fire-resistant membrane and insulation assembly which has been tested and listed by Underwriter's Laboratories, Inc. (UL) as Class A, for the roof deck and slopes to be used on this project.
- B. System Wind Rating: Roof to be warranted for a 72 mph maximum wind speed.
- C. System Types: Reinforced TPO membrane fully adhered to the top layer of insulation units.
- D. Membrane Joint System: Membrane system producer's splice tape system.
- E. Approved Products: Basis of Design: Versico "VersiWeld." or comparable listed systems:
 - 1. Carlisle "Sure-Weld."
 - 2. Firestone "Ultra Ply TPO".
 - 3. or Owner approved equal during the bidding phase.
- F. Membrane Joint System: Membrane system producer's splice tape system.

2.2 MATERIALS

- A. Membrane: TPO Roof Membrane: White, Thermoplastic Polyolefin, .060" (60 mil) thick, reinforced.
- B. Roof Insulation: High Density Rigid board insulation of foamed isocyanurate core with manufacturer's standard glass fiber reinforced mat facers or organic/inorganic facers integrally laminated to both sides; minimum R=5.7 per 1" of thickness: Insulation furnished shall be as approved by membrane manufacturer.
 - 1. Thicknesses: Top layer insulation to be 25 psi and base layer 20 psi.
 - 2. Tapered Insulation for Saddle & and Crickets: Isocyanurate units by same manufacturer as typical roof insulation; taper as required to achieve slopes indicated on drawings.
 - 3. Tapered Insulation for Sump: Basis of Design " 8 x 8 Hinged Target Sump" by Versico or equal, isocyanurate units by same manufacturer as typical roof insulation; with a 1" start and taper as required to achieve 1/2" slope.

- C. Gypsum Board Decking: Basis of Design: 1/2" "DensDeck® DuraGuard Roof Board or comparable products of other manufacturers as approved by Architect.
- D. Mechanical Anchors: Types recommended by roof system manufacturer including compression plates, for the kind of deck indicated and for wood nailers, featuring anti-corrosive materials and anti-blackout design. Anti-corrosion coating shall pass 30 cycles in Kesternich Cabinet DIN #50018 - 2 liter.
- E. Base and Parapet Flashing: Same material as used for roof membrane.
- F. Flashing To Cover Corners In Substrates: Same material as roof membrane; or roof membrane producer's unreinforced ethylene propylene-based flashing strips, .055" (55 mil) thick, of matching color.
- G. Pipe Flashings: Premolded rubber boots approved by system producer for the membrane system, complete with stainless steel, screw tightened, pipe clamps.
- H. Temporary Protection: Sheet polyethylene or fiber reinforced plastic. Provide weights to retain sheeting in position.
- I. Auxiliary Materials: Prefabricated flashing units, bonding adhesives, sealants, splicing cements, mastics and other accessory materials shall be recommended by producer of roof membrane for the system installed.
- J. Walkway Pads:
 - 1. Versico "Quick Applied Walking Pads.
 - 2. Carlisle "Sure-Seal Roof Walkway Pads" 30" wide x 30" long, 3/8" thick.
 - 3. Firestone "Walkway Pad", 30" wide x 30" long, .54" thick.
 - 4. Or approved equal. .
- K. Roof Expansion: Provide sponge tube, insulation and bellows as shown on the drawings

PART 3 - EXECUTION

3.1 GENERAL:

- A. Install roofing membrane and flashing system in accordance with details, specifications and best practices recommended by membrane manufacturer.
 - 1. Follow all recommendations and adhere to all precautions specified by roofing manufacturer except that where conflict occurs between manufacturer's recommendations and these specifications, the more stringent requirement shall prevail.
 - 2. No wet or damaged materials shall be installed.

3.2 TEMPORARY PROTECTION

- A. Temporary Protective Sheeting: Provide over uncovered deck surfaces whenever precipitation is forecast.
 - 1. Retain sheeting in position with weights or temporary fasteners.
 - 2. Provide for surface drainage from sheeting to existing drainage facilities.
- B. Traffic: Do not permit traffic over unprotected or repaired deck surface.

3.3 PREPARATION

- A. Surfaces to Receive Roofing System: Prepare so that they will be clean, dry, and free of fins, sharp edges, loose, damaged and foreign materials, oil and grease.
- B. Cleaning: Sweep roof surface clean of loose matter.

3.4 INSPECTION FOR ROOFING

- A. Acceptance of Conditions Affecting Application: Proceeding with roof system application shall designate acceptance of conditions.

3.6 INSULATION INSTALLATION

- A. Install first layer and mechanically fasten to metal deck. Install and adhere other layers of rigid insulation to the first layer of insulation.
- B. Crickets and Saddles: Slopes shall be 1/2" or as otherwise indicated on drawings. Assure positive drainage flow by installing crickets and saddles wherever flow to roof drain is obstructed, is inadequate or must be positively encouraged during storms to counter the forces of excessive runoff speeds or high winds. Take special care to correct flow patterns at rooftop equipment and where roofs have been modified. Fully adhere to insulation using adhesive as recommended by manufacturer.

3.6 INSTALLATION FOR SUMP

- A. Install Gypsum board layer and mechanically fasten to metal deck.
- B. Tapered Insulation: Adhere hinged insulation to gypsum board layer to achieve slope of 1/2" or as otherwise indicated on drawings.

3.7 ROOF MEMBRANE INSTALLATION

- A. General: Install roofing membrane and flashings in accordance with details, specifications and best practices recommended by membrane producer. Follow all recommendations and comply with all precautions specified by roofing producer except that where conflict occurs between producer's recommendations and these specifications, the more stringent requirement shall prevail.
 - 1. Direction of Membrane Placement: Orient the membrane so that rainwater runs over rather than along lap joints.
 - 2. Whole Sheets: Use whole, single sheets to the extent practicable.
- B. Membrane Installation: Lay membrane in full bed of contact adhesive for 100% adhesion.
 - 1. Relaxing: Roof membrane shall be set in place over substrate without stretching and allowed to relax 30 minutes before bonding.
 - 2. Placement: Set sheets in final position, free of wrinkles and folds, overlapping adjacent sheets, with up-hill sheet on top of joint. Make overlap 5" on membranes. Then roll sheet back evenly onto itself. Sweep away bonding contaminants from mating surfaces using a stiff bristled broom.
 - 3. Bonding Adhesive Application: Apply evenly to underside of sheet and to insulation at about the same time so as to allow matching drying times. Smooth out adhesive with nap roller. Hold bonding adhesive well back from edges to be spliced over other membrane.
 - 4. Bonding to Insulation: When bonding adhesive is tacky and does not stick or string to touch of a dry finger, roll membrane into the coated substrate slowly and evenly so as not to cause wrinkles. Compress the bond with an approved roller. Do not bond surfaces before adhesive becomes tacky. Should adhesive lose its tackiness, reapply adhesive. Set the pace of work accordingly. When first half of a sheet is fully adhered, complete other half in same manner.
 - 5. Contaminated Adhesive: Should adhesive become contaminated by dust, moisture, walking etc., re-apply adhesive, but only after contaminated adhesive is thoroughly dry, even if redoing entire field of adhesive is required. Remove contaminated adhesives when so recommended by membrane producer.
- C. Lap Splices:
 - 1. Cleaning: Sweep away excess talc and other bonding contaminants from mating surfaces using a stiff bristled broom.
 - 2. Adhesive Application: Scrub on bonding adhesive to each surface to be mated, extending adhesive 1/2" to 3/4" beyond edge of the sheet that will be laid on top. Scrub harder where there is excess dusting agent or contamination. Time the application of adhesive to each surface so as to allow matching drying times when each side of splice tape is pressed into the adhesive.
 - 3. Rolling: Roll the splice tape into the adhesive applied onto bottom sheet, leaving no edge of tape un-wet by the adhesive.
 - 4. Trimming: Trim the top sheet as required to allow splice tape to be exposed 1/8" to 1/2" after top sheet is fixed.

5. Bonding: Fix the top sheet in place by allowing the sheet to carefully fall on to the freshly exposed top surface of the splice tape, making a joint free of wrinkles and fishmouths. Broom the entire length of the splice as the splice is made and then roll the splice tight with a silicone wheeled hand roller, working across the joint and then along its length.
 6. Splices between Lengths of Splice Tape: Lap the splices at least 1" and cover such joints with a 6" x 6" patch of uncured membrane, sealed all around with lap edge sealant.
 7. Sealing Exposed Scrim: Wherever the membrane reinforcement scrim is exposed, cover with continuous bead of lap edge sealant.
 8. Sealant Application: Prime the surfaces before applying sealant and tool the sealant bead, as required by membrane manufacturer. Take caution to not disturb fresh lap sealant.
- D. Edge Attachment: Mechanically attach edges of membrane all around roof edges and roof openings, anchoring into parapets and edge blocking, according to membrane producer's recommendations and approved details.
- E. Flashing: Bond only to clean surfaces. Contour the membrane to fit substrate to which it is bonded so as not to allow bridging or gapping effect.
1. Roof Interruptions, Curbs and Edges: Flash with longest pieces practicable. Include intersections with other roofs. Terminate flashings a minimum of 8" above adjacent roof surface unless indicated otherwise.
 2. Pipe Penetrations: Flash with prefabricated rubber boots. Seal the top of boots with stainless steel strap clamps and continuous bed of mastic sealant. Form all surfaces so as to provide positive drainage.
 3. Pipe Penetrations: Seal according to Architect's approval using sealant pockets having proper metal flashings all around.
 4. Base Flashings: Membrane flashings applied over upright surfaces shall be fully adhered to substrate, all across contact area, using techniques similar to those used to bond main roof membrane.
 5. Joints In Membrane Flashings: Provide a minimum lap of 3" at joints and compress the bond with an approved roller. Round off membrane corners. Apply additional patches of flashing membrane over joints and seal all around edges, according to roof membrane system producer's recommendations.
 6. Flashing Over Fasteners: Cover the fasteners with flashing membrane, providing a minimum lap of 3" beyond washers.
- F. Expansion Joints:
1. Fill expansion voids with expansion joint insulation down to the level of the roof deck. Fill voids completely. Do not use any rigid materials.
 - a. Wrap a vapor barrier membrane around fibrous insulations and seal joints between vapor membrane sections with vapor resistant construction tape and then seal the joint between vapor barrier and curb with approved mastic.
 2. Top the expansion joint with an approved foam tube and secure the tube against dislodgement with strips of flashing membrane or as otherwise approved.

G. Temporary Closures: Install as needed to prevent water from flowing beneath roof system during inclement weather.

1. Extent: The roof membrane shall be extended at least 2 feet past edge of roof insulation and a continuous layer of sealer applied onto substrate 12" wide along the membrane edge.
2. Sealing Edge: Firmly embed roof membrane into sealer and provide continuous pressure over the length of the cut-off, using lumber and other ballast, so as to prevent blow-off.

H. Repairs:

1. Wrinkles: When within 18" of a splice or running towards a splice or positioned to interrupt proper drainage, cut out the wrinkle and repair with unspliced roof membrane to at least 3" beyond the wrinkle.
2. Cuts and Punctures: Patch over with roof membrane to at least 3" beyond the break.

3.8 INSTALLATION OF SHEET METAL WORK

A. Coordinate membrane installation with Section 076200 – Sheet Metal Work Contractor.

3.10 CLEAN UP

- A. Smears and Droppings: Clean from all non-roofing surfaces.
- B. Rubble, Debris, and Excess Materials: Remove roof construction rubble, debris, and excess roofing materials and containers.

END OF SECTION 075323

DIVISION 07 – THERMAL & MOISTURE PROTECTION

SECTION 076200
SHEET METAL WORK

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 flashings and sheet metal work not specifically included with other Sections of the Specifications but required to prevent penetration of water through exterior shell of the building:
 - 1. Metal coping.
 - 2. Overflow scuppers.
- B. Related Requirements:
 - 1. Section 042000 "Unit Masonry" for wall flashings.
 - 2. Section 075320 "TPO Roofing" for roof flashings.

1.3 SUBMITTALS

- A. Shop Drawings: Show materials, profiles, thicknesses, reinforcements, locations of work, jointing patterns, terminations, methods of installation and anchorages.
- B. Samples: Submit 2 complete sets of color options for Architect's selection, using the specified finish on the same metal as will be used for the sheet metal flashing items
- C. Certifications: Submit roof membrane producer's certification that metal items to be furnished for roofing are acceptable for inclusion in roof system producer's warranty.
- D. Warranties.

1.4 QUALITY ASSURANCE

- A. Provide water and weather-tight work, with surfaces free from waves and buckles, and seams avoided as much as possible.
- B. Comply with applicable recommendations and details of the latest editions of the SMACNA Architectural Sheet Metal Manual and the NRCA Roofing & Waterproofing Manual, including workmanship and installation

- C. Applicator: A company specializing in sheet metal flashing work and approved by membrane roofing subcontractor; having 10 years' minimum experience.
- D. Coordination:
 - 1. Coordinate fabrication and installation of metal roof flashings with roof membrane system installers so as to meet requirements of roof warranty (specified in roofing specifications Section).
 - 2. Coordinate metal flashings work with adjoining work for proper sequencing of each installation to ensure the best possible weather resistance and the protection of materials and finishes from damage.
- E. Packaging and Delivery: Deliver prefinished sheet metal components free of surface blemishes.

1.5 WARRANTY

- A. Sheet metal flashings incorporated into membrane roofing shall be compatible with the requirements of the roof system producer for inclusion into the roofing warranty.
- B. Pre-finished metal flashings shall be furnished with a written warranty covering color fade, chalking and film integrity for 20 years.
- C. Coping:
 - 1. Manufacturer's Standard Warranty: Warranted materials shall be free of defects in material and workmanship for five years after shipment. If, after inspection, the manufacturer agrees that materials are defective, the manufacturer shall at their option repair or replace them. For decorative finish warranty, consult manufacturer.
 - 2. Continuous Cleat Coping - 20-Year Excel Warranty: Manufacturer shall guarantee that a standard size roof edge system, when installed per manufacturer's instructions, will not blow off, leak, or cause membrane failure, even in wind conditions up to 110 mph, or the manufacturer shall at their option repair or replace their materials.

PART 2 - PRODUCTS

2.1 FABRICATED SHEET METAL COMPONENTS

- A. Coping System: "Permasnap Coping" by Hickman or approved equal.
 - 1. Continuous Cleat Coping: Metal coping cap with continuous anchor cleats and gutter support chairs for capping any parapet wall. The system shall be watertight, maintenance free, and not require exposed fasteners or sealant. Joints shall be butt type with concealed splice plates
 - 2. Performance characteristics:
 - a. Coping sections shall expand and contract freely while mechanically locked in place on anchor cleat.

- b. Coping sections shall lock to anchor cleats by mechanical pressure from support chairs.
 - c. All coping cover joints shall be underlaid with gutter/support chairs capable of draining water.
- 3. Metal: .063" aluminum for all sizes with Kynar coating; color as selected by Architect from manufacturer's standard range of colors.
- 4. Coping cap: Length of 10'-0" (3048 mm); width of as detailed on drawings.
- 5. Coping vertical face and back leg: standard 4" (100 mm) nominal.
- 6. Internal splice plates: Shall be concealed with matching finish to maintain outside face continuity.
- 7. Coping Cleat: 24 gauge galvanized steel anchor cleat, 10'0" lengths.
- 8. Coping Clip: 20 gauge clip normally 12" (305 mm) wide @ 60" (1524 mm) on center (40" o.c. for walls greater than 17") to be mechanically fastened as indicated and detailed.
- 9. Fasteners: Shall be screw type with a minimum pull-out resistance of 240 # (109 kg) as supplied by the manufacturer per substrate application. No exposed fasteners shall be permitted. Fasteners shall be electrolytically compatible.
- 10. Accessories:
 - a. Corners, end caps, pier caps, etc. shall be fabricated by the coping manufacturer.
 - b. METAL-LOK[®] assembly shall be used to maintain watertight integrity.
 - c. Sheet Metal Flashings: Two-piece construction, made from .063" aluminum with Kynar coating; color as selected by Architect from manufacturer's standard range of colors. Front face to be formed for attachment with continuous cleat. Provide bent out drip at all bottom edges. Corners units shall be mitered and welded or locked and solder sealed.
 - d. Overflow Scuppers: Made from .063" aluminum with Kynar coating; color as selected by Architect from manufacturer's standard range of colors. Include all accessories required.
- B. Finish: Coping system and all fabricated sheet metal components shall have factory applied fluoropolymer coating containing a minimum of 70%, by weight, Kynar 500, Kynar 500 VLD or Hylar 5000 resin; colors as selected by Architect from manufacturer's full range of standard options.

2.2 AUXILLIARY MATERIALS

- A. Flashing Cement: Asphalt mastic cement formulated for weathering and flow resistance, meeting requirements of Fed. Spec. SS-C-153.
- B. Adhesives for sheet metal flashings in contact with TPO roofing shall be type recommended by flashing sheet manufacturer and approved by roofing system manufacturer to provide a waterproof/weather-resistant seaming and adhesive application compatible with roofing system materials.

- C. Dissimilar Metal Protection: Bituminous coating conforming to Fed. Spec. TT-C-494 or SSPC-Paint 12, or plastic separators, or insulating tape, subject to Architect's approval.
1. For metal flashing in contact with roofing, use separation materials or methods compatible with roofing system materials as approved by roofing system manufacturer.
- D. Nails and Fasteners:
1. Use same metal for fastener as metal being attached; and assure that nail heads are significantly larger than the nailing slots in the flashings.
 2. For Cleats to Nailers: Use ring-shank or screw-shank nails long enough to penetrate the wood nailer at least 1-3/4" or use #8 screws long enough to penetrate the wood nailer 3/4".
 3. For Fastening Galvanized Metal Flashings: Hot-dip galvanized nails of Stronghold type, with large, flat heads and shanks not smaller than No. 12 Stubbs gauge (0.109") and of sufficient length to penetrate wood blocking at least 7/8".
 4. For Exposed Fastening: Provide fasteners with soft neoprene washers.
 5. For Continuous Cleat Coping System: mechanical fasteners with minimum 240 # (109 kg) pull-out resistance as supplied manufacturer; threaded and suitable for parapet substrates
- E. Protective Backing Paint: Zinc chromate alkyd.

2.3 FABRICATION

- A. General:
1. Fabricate all metal flashings necessary to provide complete leakproof conditions throughout the Work. Examine roof plans, details, sections and Mechanical Drawings to determine scope of sheet metal flashing work required.
 2. Make work weathertight, according to field measurements, formed true to detail, with sharply defined profiles, accurate in size, and free from distortion and defects. Do not use any techniques that will invalidate the warranty on precoated materials. Form pieces in longest lengths practical.
 3. Expansion: Holes for fasteners shall be punched slots. Provide 4" end laps accurately fitted and firmly fastened in all continuous runs of sheet metal work, at intervals no more than 10 ft. Fill end laps with specified mastic. Provide slip joints on downspouts.
 4. Drip Edges: All exposed edges of flashing shall have 1/2" projecting hemmed edge.
- B. Seams: Single-locked and solder soaked, or double-locked and malleted flat, at least 1/2" wide unless otherwise specified or detailed, to lap in direction of flow.
1. Joints: Solder and seal joints. Completely fill seams. After soldering, neutralize and remove flux. Wipe and wash solder joints clean as work progresses.
 2. Corners Between Units: Fabricate from one piece with minimum 10" long legs; solder for rigidity, seal with sealant

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate with other trades to provide flashings, etc., to secure their work.
- B. Clean surfaces to be covered, removing dirt and other foreign matter.
- C. Flashings shall be installed to prevent galvanic action with dissimilar metals by priming with heavy coat of bituminous paint (min. 7.5 mil DFT).
- D. Prepare all surfaces where dissimilar metals meet, using dissimilar metal protection materials hereinbefore specified.

3.2 INSTALLATION

- A. General: Secure flashings in place using concealed fasteners. Use no exposed fasteners except as detailed. Install work watertight, making allowances for expansion and contraction. Install fasteners snug; do not over-tighten. Finished work shall be free of waves, warps, buckles, fastening stress, and distortions.
- B. Cleats For Edgings: Install over a continuous bead of butyl sealant applied to the bottom of the vertical flange of the cleat. Install with annular threaded or ring-shank nails 16" o.c. When within 8 ft of outside corners, double the fasteners. Double-nail at ends of runs.

3.3 TOUCHUP

- A. Repair or replace any portions of flashing work that have been damaged.
- B. Minor damage to finish may be repaired in accordance with metal manufacturer's recommendations. Architect shall be sole judge of acceptability of repairs to damaged finishes; replace sheet metal that cannot be repaired to the satisfaction of the Architect.

END OF SECTION 076200

DIVISION 07 – THERMAL & MOISTURE PROTECTION

SECTION 078400
FIRESTOPPING

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. Firestopping systems for the firestopping of top and ends of fire rated partitions and where elsewhere designated on drawings.
- B. Sealing of **ALL** sleeved and un-sleeved pipe, conduit, cable, cable tray, duct and similar penetrations through **ALL** rated walls and partitions.
- C. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for miscellaneous sealant work.
- D. With respect to fire stopping of pipe, pipe sleeves and conduit penetrations, the requirements of this Section apply and are to cover fire stopping requirements specified in Mechanical and Electrical Divisions. Work of this Section shall be coordinated with Mechanical and Electrical contractors as required to assure compliance with the fire stopping requirements specified in Mechanical and Electrical Divisions.

1.3 SUBMITTALS

- A. Schedule of Applications: Submit 6 copies of a usage schedule showing what products will be used for which situations.
 - 1. Submit detailed drawings of all firestopping systems to be used, giving names of materials and means of installation. Indicate the appropriate UL or FM approval number with each drawing.
 - 2. On a plan drawing of the project, reduced in scale as convenient, indicate where each kind of firestopping system submitted will be located.
- B. Product Data: Provide data on characteristics, performance and limitation criteria of products.
 - 1. Include manufacturer's material safety data sheets (MSDS).
 - 2. Manufacturer's Installation Instructions: Include preparation and installation procedures required.

C. Certificates.

1. Manufacturer's Certification: Submit manufacturers' letters of certification verifying acceptability of proposed Fireproofing Installer.
2. Verification of Installation: Contractor shall submit letter certifying that fire stopping has been installed complete and in accordance with all specifications.

D. Sample Warranties: For manufacturer's warranties.

1.4 QUALITY ASSURANCE

A. Installer: Firestopping Installer shall complete the installations as specified and to the satisfaction of all authorized inspectors.

B. Manufacturer's Representative: Each manufacturer furnishing materials for the work shall have an on-site representative to perform the following:

1. Assist Installer with selection of correct products for the various conditions of installation.
2. Train Installer's personnel in proper installation procedures, including quantities of materials necessary to meet the fire resistance ratings required.
3. Verify throughout the course of the work that correct installation procedures are being used.

C. Firestopping Systems' Performance Requirements:

1. Fireproofing Resistance: As appropriate to the fire rating(s) noted on the Drawings, per ASTM E 814.
 - a. Flame and Temperature Ratings: As required by the pertinent building codes, according to test results produced in nationally accepted test agencies from tests conducted per ASTM E 814 or UL 1479. Flame (F) rating must be no less than the fire resistance rating of the assembly through which it is applied. Temperature (T) rating, when required by code authority, shall be measured under a positive pressure differential of at least .01" of water column.
2. Expansion Joint Materials: Tested for F, T and L ratings per UL 2079 at full extension after 500 expansion/contraction cycles.

D. Product Compatibility: In each type of firestopping system used, each component shall have been tested and approved for use with the other components installed.

E. Verification of Compliance: The Contractor shall provide to the Architect, prior to final payment, a letter of certification verifying that all perimeters of fire resistance rated constructions as well as penetrations through fire resistance rated constructions were completed as required by Code and the requirements of this Section

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original, unopened packaging with intact labels identifying product, UL labels, lot number and use-by date.

- B. Store materials at site in one location, in original containers, under conditions recommended by manufacturer.
- C. No material shall be used which has exceeded its shelf life.

1.6 PROJECT CONDITIONS

- A. Install materials only under the conditions of temperature and humidity recommended by manufacturer of product to be installed.
- B. Coordinate with other trades as required to assure proper installation of their work and the firestopping work. Install firestopping at drywall penetrations before finishing is started on drywall joints.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

- A. Acceptable Manufacturers: Products shall be produced by one or more of the following manufacturers:
 - a. Sonneborn Div. of ChemRex Inc.
 - b. Hilti.
 - c. 3M Brand Products.
 - d. RectorSeal Metacaulk.
 - e. Tremco.
 - f. or Owner approved equal during the bidding phase.
- 2. Acceptable Products: Use one of the following or similar produced by a manufacturer listed above:
 - a. Hilti "FS-One" sealant with matching backer, and Hilti "FS-Fire Block."
 - b. Sonneborn "NP2" sealant with BackerRod Mfg's "Ultra Block" fire blocking mat.
 - c. or Owner approved equal during the bidding phase.

2.2 MATERIALS

- A. General: Use only UL listed materials complying with ASTM E 814 (UL 1479) or ASTM E 119 (UL 263) and appropriate to the kind of opening and kind of item penetrating the opening, as required to maintain the indicated fire rating of the construction assembly penetrated:
 - 1. Materials shall be VOC compliant.
 - 2. Materials shall be free of materials requiring hazardous waste disposal, including PCBs, lead and asbestos.
 - 3. For each kind of firestopping situation, use materials from only one manufacturer.
- B. Safing Insulation: Either unfaced mineral fiber OR ceramic fiber insulation, as required by system manufacturer

- C. Accessories: Furnish sleeves, confinement collars, dam material, primers, sealants and other placement and attachment accessories as recommended by manufacturer and as necessary to establish the required fire ratings
- D. Identification Labels: Plastic or plastic shielded paper, configured for permanent attachment and bearing the following information:
 - 1. FIRESTOP SYSTEM - DO NOT DISTURB.
 - 2. (Manufacturer's Name).
 - 3. System Number _____.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Verify that openings are ready to receive the work of this Section and that elements penetrating the floors, walls and partitions have been permanently affixed. All penetrations are to have sleeves, except as approved otherwise by Architect.
- B. Verify that pipe sleeves have been properly installed.
 - 1. Pipes and conduits shall be sleeved with un-split Schedule 40 pipe solidly joined to masonry with mortar, to drywall with joint compound and to concrete with mortar.
 - 2. Pipe sleeves shall be sized to maintain a minimum gap of 1" all around the pipe or conduit (including any insulation on the pipe), irrespective of whether the pipe or conduit is aligned with the center of the sleeve or is off-center.
 - 3. The pipe sleeve's length shall be 1" longer than the thickness of the wall assembly, so that it shall extend out from each face of the wall or partition by 1/2".
 - 4. The pipe sleeve's length at floors shall be 2 1/2" longer than the thickness of the floor assembly, so that it shall extend 2" above the rough floor elevation and 1/2" below the bottom of the floor assembly.
- C. Verify that pipes are not insulated with any materials inappropriate to the rated fire stopping system.
- D. Should an area requiring firestopping be covered up with other construction or should other conditions unsatisfactory for a proper installation be found, such as lack of sleeves, report the conditions to Contractor for rectification, and send copy of report to Architect. Do not proceed with installation until unsatisfactory conditions have been corrected.
- E. Clean substrate surfaces of dirt, dust, grease, oil, loose material and other matter that might affect bond of firestopping material.
- F. Protect adjacent surfaces from damage due to material installation.

3.2 APPLICATION

A. General:

1. Apply materials in accordance with manufacturer's instructions, in the same manner as was used to achieve the UL design listing.
2. Apply firestopping materials to uniform densities and texture, in sufficient quantities to achieve required fire resistance rating. Keep exposed work neat.
3. Where additional layers of construction create voids in addition to the primary floor or partition, treat the extra voids the same as primary voids, assuring that fire, smoke and gases are restricted from flowing in any voids.
4. Install retention dams as required. After curing of firestop materials, incombustible dams may be left in place; combustible dams shall be removed.

B. Penetrations Through Fire Rated and Smoke Rated Interior Walls And Partitions:

1. Apply firestopping wherever a void has been made in a wall or partition for the penetration of pipes, conduit, wire, cables, ducts, sleeves, or other items which could allow passage of flame, smoke or gases in the event of a fire —whether that wall or partition is rated or not rated.
2. Ensure that any voids between the sleeve and the surrounding construction are filled and firestopped to the same degree as voids within the sleeve.

C. Tops Of Interior Walls And Partitions: At tops of masonry partitions and gypsum partitions, which are fire rated or smoke rated, create a fire and smoke barrier by installing firestopping between the top of the wall or partition and the deck above.

D. Permanently affix adjacent to each installation in a fire-rated wall the label specified above, properly identifying the firestopping system installed.

E. Correct any firestops that do not conform to the requirements specified, at no additional charge to the Owner

3.3 CLEANING, AND PROTECTION

A. Clean firestopping materials from adjacent surfaces.

B. General Contractor shall protect work of this Section from damage by other trades.

END OF SECTION 078400

DIVISION 07 – THERMAL & MOISTURE PROTECTION

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 joint sealants for interior applications:
- B. Related Requirements:
 - 1. Section 033000 "Cast-In-Place Concrete" for sealing of floor joints.
 - 2. Section 042000 "Unit Masonry" for sealing of masonry walls.
 - 3. Section 061000 "Carpentry Work" for sealing of sink perimeters in plastic laminate countertops.
 - 4. Section 076200 "Sheet Metal Work" for sealing joints in sheet metal work.
 - 5. Section 081113 "Hollow Metal Doors Frames" for perimeter sealing of door frames at walls.
 - 6. Section 084113 "Aluminum Framed Entrance" for perimeter sealing of entrance frames at walls.
 - 7. Section 085113 "Aluminum Windows" for setting exterior thresholds in sealant.
 - 8. Section 087100 "Finish Hardware" for perimeter sealing of door frames at walls

1.3 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish watertight and airtight continuous seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. Product Data: For each type of joint sealant product.
- B. Samples: For each kind and color of joint sealant required.
- C. Joint Sealant Schedule: Include the following information:
 - 1. Joint sealant application, joint location and designation.
 - 2. Joint sealant manufacture and product line.
 - 3. Joint sealant formulation.
 - 4. Joint sealant color.

- D. Product Test Reports.
- E. Preconstruction compatibility and adhesive test reports.
- F. Preconstruction field adhesion test reports.
- G. Field adhesion test reports.
- H. Warranties.

1.5 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which 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.

PART 2 - PRODUCTS

2.1 MAUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of, the products listed herein.

2.2 JOINT SEALANTS

- 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. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated in accordance with 40 CFR 59, Part 59, Subpart D (EPA Method 24):
 1. Architectural sealants shall have a VOC content of 250 g/L or less.
 2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
 3. Sealants and sealant primers for porous substrates shall have a VOC content of 775 g/L or less.
- C. Liquid Applied Sealants: Sealants and sealant primers shall comply with ASTM C 920 and other requirements for each liquid applied joint sealant specified including those referencing ASTM C 920 classifications for type, grade, class and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids: Where sealants are indicated of Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing in accordance with ASTM C 1247. Liquid used for testing is deionized water unless otherwise indicated.
- D. Stain Test Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing in accordance with ASTM C 1248 and have not stained porous joint substrates indicated for the project.
- E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with CFR 177.2600.
- F. Colors of Exposed Joint Sealants: Color to be selected by Architect.

2.3 SEALANT TYPES

- A. Sealant for General Exterior Use, Exterior and Interior Side of Aluminum Windows and Entrance Frames, including Thresholds, Provide the following:
 1. Sonneborn150 Basis-of-Design. Equal by:
 2. Dow
 3. Tremco
- B. Sealant: Sealant for Interior Control Joints. Provide the following:
 1. Sonneborn “Sonolastic Ultra” Basis-of-Design. Equal by:
 2. Sika
 3. Pecora
 4. Tremco
- C. Sealant: Sealant for Sink Surrounds and Other Interior Wet Areas. Provide the following:
 1. Sonneborn “Sonolastic OmniPlus” Basis-of-Design. Equal by:
 2. Sika
 3. Pecora
 4. Tremco
- D. Sealant: Sealant for Joints at Floor Perimeters. Provide the following:
 1. Sonneborn “Sonolastic SL1” Basis-of-Design. Equal by:
 2. Sika
 3. Pecora
 4. Tremco
- E. Sealant: Sealant for Joints in Floors. Provide the following:
 1. Sonneborn “Sonolastic SL1” or “Sonolastic SL2” Basis-of-Design. Equal by:
 2. Sika
 3. Pecora
 4. Tremco

F. Sealant: Sealant for Other Interior Uses. Provide the following:

1. Sonneborn "Sonolastic Sonolac" Basis-of-Design. Equal by:
2. Sika
3. Pecora
4. Tremco

G. Sealant: Lap Sealant for Coping and Sheet Metal Flashing Joints. Provide the following:

1. Sonneborn "Butakauk" Basis-of-Design. Equal by:
2. Sika
3. Pecora
4. Tremco

2.4 JOINT FILLER

A. Joint Filler:

1. Backer rod for elastomeric sealants. Extruded closed cell polyethylene foam or polyethylene jacketed polyurethane foam, non-bleeding, non-staining, oversized 30 to 50 percent; provide one of the following:
 - a. Emseal: Backerseal (Greyflex) Basis of Design. Equal by:
 - b. Dow
 - c. Meadows
 - d. Sonneborn
2. Joint Seal. Factory applied low modulus silicon with open cell polyurethane infused with water-based non-drying acrylic dispersion; width as detailed on drawings: Provide one of the following:
 - a. Emseal: Seismic Colorseal Basis of Design. Equal by:
 - b. Dow
 - c. Meadows
 - d. Sonneborn

2.5 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Non-staining; 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. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas and capable of remaining resilient at temperatures down to minimum 26 deg. F (minimum 32 deg. C). Provide product with low compression set of size and shape to provide a secondary seal, to control sealant depth and otherwise contribute to optimum sealant performance.

- D. 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.

2.6 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: Non-staining, 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.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - 3. Remove laitance and form-release agents from concrete.
 - 4. 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:
- 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. Exterior Thresholds: Apply 2 continuous beads of sealant, one near each of the interior and exterior edges of the threshold.
- E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. Tooling of Non-sag 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 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.

3.5 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.

END OF SECTION 079200

SECTION 081113

HOLLOW METAL DOOR 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:
 - 1. Providing and installing new interior fire rated hollow metal door frames.
- B. Related Requirements:
 - 1. Section 087100 "Finish Hardware" for hollow metal door frame hardware.
 - 2. Section 099000 "Painting" for finish painting of new hollow metal door frames.

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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 2. Locations of reinforcement and preparations for hardware.
 - 3. Details of each different wall opening condition.
 - 4. Details of anchorages, joints, field splices, and connections.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For hollow metal door and frame assembly, for tests performed by a qualified testing agency.

1.7 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.
- 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- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each unit to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Acceptable Manufacturers:
 - 1. Hollow metal door frames shall be manufactured by one of the following:
 - a. Ceco.
 - b. Curries.
 - c. Precision Metals.
 - d. Philipp.
 - e. Steelcraft.
 - f. Security Metal Products Corp.
 - g. or Owner approved equal during the bidding phase.

2.2 INTERIOR HOLLOW METAL DOOR FRAMES

- A. Construct interior frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Interior Frames: Form frames from 16-gauge sheet steel, with machine-mitered corners of interlock construction having faces only welded.
 - 1. Fire-Rated Frames: Construct frames occurring in fire rated openings to meet and receive fire resistant ratings scheduled.
 - 2. Openings: Shall be properly sized for the kind of glazing used and shall be so labeled

2.3 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 Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
 - 4. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
 - 5. Head Anchors When recommended by Manufacturer): Two anchors per head for frames more than 42 inches (1067 mm) wide and mounted in metal-stud partitions.
 - 6. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick
- C. 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 door frames to receive nontemplated, mortised, and surface-mounted hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.4 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. 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 frames to receive nontemplated, mortised, and surface-mounted 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 Frames: Install hollow-metal frames for doors, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - b. Install door silencers in frames before grouting.
 - c. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - d. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - e. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

DIVISION 08 – OPENINGS
SECTION 081416
FLUSH WOOD 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:

- 1. Solid-core fire rated doors with wood-veneer faces.
- 2. Factory fitting flush wood doors to frames and factory machining for hardware.
- 3. Preparation of wood doors for glazed openings.

B. Related Requirements:

- 1. Section 061000 "Carpentry" for finish hardware installation.
- 2. Section 081113 "Hollow Metal Door Frames" for hollow metal door frames.
- 3. Section 087100 "Finish Hardware" for wood door finish hardware.
- 4. Section 088000 "Glazing" for wood door glazing.
- 5. Section 099113 "Painting" for wood door stain and finish coating.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Undercuts.
 - 4. Details of openings for glazing.
 - 5. Fire-protection ratings for fire-rated doors.
- C. Samples for Verification:
 - 1. Provide Samples for species of veneer and solid lumber required.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.5 QUALITY ASSURANCE

- A. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL 10C.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.

1.7 WARRANTY

- A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 TYPE AND MANUFACTURERS

- A. Construction: Solid core, flush, wood veneer faced door of 5-ply hot press or 7-ply cold press construction, 1-3/4" thick, fire rated. Factory finish, standard stain finishes shall be selected.
- B. Acceptable Manufacturers: One of the following:
 - 1. Algoma Hardwoods, Inc.
 - 2. Eggers Hardwood Products Corp.
 - 3. Oshkosh Architectural Door.
 - 4. V.T. Industries, Inc.
 - 5. Graham Manufacturing Corp.
 - 6. or Owner approved equal during the bidding phase.

2.2 MATERIALS AND CONSTRUCTION

A. Face Panels:

1. Construction for Factory Finish: 2-ply face panels. Manufacturer's standard 3-ply face veneers will be accepted in lieu of 2-ply.
2. Face Veneer Species, Grade and Cut: Plain sliced Red Oak, premium grade, book match, Type I, Grade A, per AWI "Quality Standards" Section 01300 and C.S. 171-64. (No rotary or half round sliced veneers accepted.).

B. Crossbands (5/7-Ply Construction): Hardwood or natural/engineered fiberboard, minimum 1/16" thick, tapeless spliced, no voids.

C. Cores:

1. Provide mineral core as needed to provide fire-protection rating indicated.
2. Thickness: Matched to face veneer and crossband thicknesses so as to produce a door 1-3/4" thick.

D. Stiles & Rails: Solid, sound wood or structural composite lumber (SCL), 1-3/8" minimum total width for stiles, 1-1/8" for rails, securely bonded to the core and then abrasively planed before application of face veneers to ensure minimal telegraphing of core parts through veneers.

1. Finish the vertical edges of door with hardwood of same species and grade as door veneers.
2. Stile Edge Split Resistance: Minimum of 750 lbs when tested per ASTM D 143-52/78 Modified.
3. Screw Withdrawal Resistance: Minimum of 740 lbs when tested per ASTM D 1037-78.

E. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated.
3. Temperature-Rise Limit: At exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

F. Glazing Stops In Fire Rated Doors: Wood-faced steel glazing stops, bonderized and prime finished for finish painting under Section 091000 - Painting.

2.3 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

1. Comply with NFPA 80 requirements for fire-rated doors.

- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.

2.4 DOOR FINISHING

- A. Doors to receive factory finish from manufacturers full selection of stain finishes for Red Oak. Stain finish/colors selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
- C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - 1. Clearances: Comply with NFPA 80 for fire-rated doors..
 - 2. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

DIVISION 08 – OPENINGS
SECTION 084113
ALUMINUM FRAMED ENTRANCES

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. Aluminum entrance doors and frames.
2. Seals around frame perimeters.
3. Weatherstripping.
4. Installation of hardware furnished for aluminum entrances by hardware supplier as specified in Section 087100 - Finish Hardware.
5. Perimeter sealant installation in accordance with requirements of Section 079200 - Joint Sealants.

- B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing at aluminum door frames
2. Section 087100 "Finish Hardware" for finish hardware to be installation on new aluminum doors.
3. Section 088000 "Glazing" for glazing for new aluminum doors and frames.

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications: Company specializing in installation of systems of the type specified for 5 years, and approved by system manufacturer.
- B. Fabrication Tolerances: Fabricate aluminum storefront in accordance with framing manufacturer's prescribed tolerances.
- C. Thermal Break Components: Manufactured to meet the following standards:
1. AAMA QAG 1–98, “Quality Assurance Processing Guide for Poured and Debridged Polyurethane Thermal Barriers.”
 2. AAMA TIR A8–90, “Structural Performance of Poured and Debridged Framing Systems.”
 3. AAMA 505-98, “Dry Shrinkage and Composite Performance Thermal Cycling Test Procedure.”

D. Coordination:

1. Installer of aluminum entrance doors and frames shall be responsible for installing each complete with glass and perimeter sealant.
2. Coordinate with Finish Hardware Supplier as required to assure proper fitting of hardware items furnished under Section 087100.
 - a. Hardware Installation: According to templates approved by hardware item manufacturers.
 - b. Hardware Templates: Report to Architect in writing should templates not be delivered by Hardware Supplier in sufficient time to meet construction schedules.
3. Glazing: Installer of aluminum entrance doors shall be responsible for installing them complete with glass.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and finishes.

B. Shop Drawings: Show elevations and details, including gaskets, weatherstripping, methods of anchoring, type of alloy, finishes; size and thickness of individual parts, dissimilar metal protection.

C. Samples: Submit for Architect's review:

1. 2 samples 6" long of each color available for each type of glazing sealant and gasket exposed to view.
2. Full size samples of each framing system.

D. Certificates: Submit manufacturer's certification that Installer is approved by manufacturer.

1.5 PRODUCT STORAGE, AND HANDLING

A. Uncrate doors, frames and related accessories and store in strict compliance with the manufacturer's instructions. Remove all padding and packing in contact with aluminum immediately upon arrival in order to prevent staining.

1.6 WARRANTIES

A. Manufacturer shall agree to repair or replace units whose components fail due to inferior materials or workmanship within 10 years of installation. Failures shall include but are not be limited to:

1. Structural failures including excessive deflection, leakage or air infiltration.
2. Failure of insulating glass, including interpane dusting or misting and internal dew point rising above -50°F.

B. Finishes: Manufacturer's standard warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER AND TYPE

A. Acceptable Products:

1. Aluminum Door Frame: TriFab "VG 451T" as manufactured by Kawneer as the Basis-Of-Design or equal by Efco, Tubelite, or YKK AP or Owner approved equal during the bidding phase.
 - a. Frames shall have with a nominal profile of 2" x 4 1/2".

2.2 MATERIALS AND CONSTRUCTION

A. Aluminum (Framing and Components):

1. Material Standard: ASTM B 221; 6063-T6 alloy and temper.
2. Wall Thickness: minimum wall thickness of 3/16."
3. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.
4. Thermal Breaks: Manufacturer's standard type. Poured-in-place polyurethane type shall have maximum tensile strength of 4,300 psi.

B. Accessories:

1. Fasteners: Where exposed, shall be Stainless Steel.
2. Gaskets: Glazing gaskets shall be extruded EPDM rubber.
3. Perimeter Anchors: Aluminum. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
4. Dissimilar Metal Protection: Alkali resistant bituminous paint conforming to AN-P 31, plastic separators, insulating tapes or manufacturer's standard, subject to Architect's approval.

C. Weatherstripping: Thermoplastic elastomer weatherstrip system on all sides of exterior doors and/or frames, meeting AAMA 702 requirements. Provide surface applied bottom weatherstrip with flexible blade gasket at bottoms of doors.

D. Internal Joint Sealant: Polyisobutylene non-hardening thin-joint sealant "Presstite #579" or equal.

E. Sealants: See Section 079200 - Joint Sealants.

F. Glass: See Section 088000 - Glazing.

G. Material Separation: Provide a coating or material between dissimilar materials as recommended by aluminum door manufacturer to protect against corrosion of aluminum materials.

2.3 FABRICATIONS

- A. Fabricate components per manufacturer's installation instructions and with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- B. Accurately fit and secure joints and corners. Make joints flush, hairline and weatherproof.
- C. Prepare components to receive anchor devices. Fabricate anchors.
- D. Arrange fasteners and attachments to conceal from view.

2.4 ENTRANCE DOORS

- A. Doors shall be heavy duty swing type, "Tuffline 500" (2" deep) by Kawneer Company as Basis-Of-Design or equal by Efco, Tubelite, or YKK AP or Owner approved equal during the bidding phase.
- B. Hardware and Lock Cylinders: As furnished under Section 087100 – Finish Hardware.

2.5 FINISH

- A. Exposed Metal Surfaces: Manufacturer shall provide baked-on fluoropolymer coating having 70% Kynar 500 or Hylar 5000 resin, in a custom color selected by Architect.
- B. Unexposed metal surfaces may remain uncoated.

2.6 FABRICATION

- A. General: Fabricate and assemble in as large sections in shop as consistent with shipping and field requirements.
- B. Joints: Shall be flush, hairline. Field splices and joints between sections shall produce strength to resist misalignment and deformations imposed by handling and live loads. Keep fasteners concealed.
- C. Doors: Corners: Dual moment construction consisting of mechanical fastening using extruded aluminum channel clips and bolt fasteners and SIGMA deep penetration plug welds and fillet welds.
- D. Reinforce doors and frames for hardware with backing plates of non-magnetic steel or hot-dip galvanized steel complying with ASTM A 36.
 - 1. Reinforce for butt hinges with 1/4" steel plates 10" long welded to aluminum with 6 welds, each 1/2" long.
 - 2. Reinforce for closers with 10-gauge plate, 12-gauge plate for other hardware.
 - 3. Reinforce for all other cutouts and mortises similarly.
- E. Provide positive means to drain to the outside any water entering the system.
- F. Glazing: Glazing as specified under Section 088000 – Glazing.

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. 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 frames to receive nontemplated, mortised, and surface-mounted hardware.
- C. All surfaces that may contact steel, concrete or masonry construction shall be prepared with dissimilar protection materials hereinbefore specified. Aluminum surfaces to remain exposed shall be protected from bituminous paint application.

3.3 INSTALLATION

- A. Set frames in locations shown, level, plumb and in line. Seal joints between framing members and mullions. Where moldings are jointed, accurately cut and fit members to result in tightly closed joints.
- B. Do not use exposed fasteners except as approved by Architect.
- C. Internal Drainage: Cut, join and seal members to form positive paths of drainage within the framing in order to prevent any water that may enter the system from leaking through to interior of building.
- D. Frame Anchors: Unless indicated or approved otherwise, space anchors all around opening at not more than 24" o.c. Powder-actuated fasteners will not be allowed.
- E. Glazing Beads: Make corners square, butted and tightly fit.
- F. Glazing Seals: Furnish seals to glass installer, ready for installation of glazing under Section 088000 - Glazing.
- G. Hardware: Coordinate installation of hardware furnished under requirements of Section 087100 – Finish Hardware.
- H. Apply sealant to both sides of perimeter of frames, using materials and methods specified in Section 079200 - Joint Sealants, including submissions.
- I. Install Material Separation: Provide a coating or material between dissimilar materials as recommended by aluminum door system's manufacturer to protect against corrosion of aluminum materials.

3.4 ADJUSTING, CLEANING AND PROTECTION

- A. Hardware Adjustment: Adjust and check each operating item, to ensure proper operation and function.
- B. Hardware Lubrication: Lubricate moving parts with lubricant recommended by manufacturer. Use graphite-type lubricant if none other recommended.
- C. Hardware Replacement: Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended.
- D. Cleaning: Clean aluminum surfaces promptly after installation of frames and doors, exercising care to clean corners and to avoid damage of the protective coating (if any). Remove excess glazing and sealant compounds, dirt and other substances. Final cleaning will be done by General Contractor just prior to time of acceptance.
- E. Touch-Up: Scratches and abrasions shall be touched-up with finish manufacturer's recommended coating, to satisfaction of Architect.
- F. Protection:
 - 1. General Contractor shall provide protective measures and other precautions as required through remainder of construction period, according to recommendations of Installer, to ensure that doors and frames will be without damage or deterioration (other than normal weathering) at time of acceptance.
 - 2. Plastic films applied for protection during shipment shall not be used for protection after installation of aluminum.

END OF SECTION 084113

DIVISION 08 – OPENINGS
SECTION 085113
ALUMINUM FRAMED WINDOWS

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 windows for exterior locations.
- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for sealant application of perimeter joints between aluminum fenestration units and masonry walls.
 - 2. Section 088000 "Glazing" for glazing aluminum fenestration units.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
- C. Samples: For each exposed product and for each color specified, 2 by 4 inches in size.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
 - 1. Include similar Samples of hardware and accessories involving color selection.
- E. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes, and prepared on Samples of size indicated below:
 - 1. Exposed Finishes: 2 by 4 inches in size
- F. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturer's warranties.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- C. Field Testing:
 - 1. Contractor shall engage and pay a qualified testing agency to perform tests and inspections.
 - 2. After the first window has been installed and prior to installing any other windows, testing shall be conducted on the first window as described under Section 3.3 Field Quality Control.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship for warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
 - c. Deterioration of materials and finishes beyond normal weathering.
 - d. Failure of insulating glass.
 - 2. Warranty Period:
 - a. Window: 10 years from date of Substantial Completion.
 - b. Aluminum Finish: Manufacturer's standard warranty from date of Substantial Completion.
 - c. Installer shall provide a 5 year warranty for a watertight condition.

PART 2 - PRODUCTS

2.1 WINDOW TYPES & MANUFACTURERS

- A. Aluminum windows shall consist of thermal break type aluminum frame sections as shown.
 - 1. Exterior Fixed Windows shall be Kawneer TriFab "VG-451T" (outside glazed) as the Basis-Of-Design or equal by Efco, Tubelite, or YKK AP or Owner approved equal during the bidding phase.
- B. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/IS.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

2.3 WINDOW MATERIALS AND COMPONENTS

- A. All aluminum members, frames, sash bars, glazing beads, muntins and mullions shall be extruded from 6063T alloy of suitable temper and have a minimum tensile strength of 28,000 psi.
 - 1. No main member shall have a wall thickness less than .070"
 - 2. Aluminum glazing beads shall be snap-in type with a minimum wall thickness of .050".
 - 3. Sills/subsills shall have a minimum wall thickness of .090".
- B. Aluminum Glazing Beads: Extruded snap-in type with glazing legs no less than 3/4".
- C. Thermal Barrier: Poured in place polyurethane with max. tensile strength of 4300 psi.
 - 1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
- D. Weatherstripping: Two rows of jacketed foam or neoprene fin gaskets or polypropylene pile installed in dovetailed grooves extruded in sash members and secured to prevent movement, shrinkage or loss. Jacketed type shall conform to AAMA 701.2.
- E. Glazing Seals: As furnished by window manufacturer; color as selected by Architect from manufacturer's standard color options. Any of the following types may be used:
 - 1. Extruded EPDM dry gasket seals with impervious skins.
 - 2. Extruded vinyl dry gasket seals with impervious skins, meeting ASTM D 2287.
 - 3. Extruded neoprene dry gasket seals with impervious skins, meeting ASTM D 2000, type 2BC415 to 3BC415.
 - 4. Extruded silicone dry gasket seals with impervious skins.
 - 5. Expanded neoprene gaskets with impervious skins meeting ASTM C 509, Grade 4.

6. Butyl tape and silicone wet seals as standard to window manufacturer.
- F. Anchors: Aluminum or steel. When anchors are steel they must be primed with shop coat of approved zinc chromate primer and insulated from the aluminum members or must be cadmium or zinc plated to meet ASTM A 165 or A 164 requirements.
- G. Fasteners:
1. Frame Assembly Fasteners: Non-magnetic stainless steel.
 2. Miscellaneous Fasteners: Aluminum or non-magnetic stainless steel, with finish color to match frames where exposed to view.
 3. Frame Anchor Clip Fasteners: Expansion bolts, toggle bolts or lag screws, as required by building construction material, not less than 1/4" dia., cadmium or zinc plated steel in accordance with ASTM A 164 and A 165.
 4. No plastic expansion anchors allowed.
- H. Sills/Subsills:
1. Extruded aluminum sections shall assure that any water entering the glazing channels will be positively weeped to the exterior. Furnish sills with sub-structural components, such as legs and/or blocking, so as to assure complete support of the sill across the window opening.
 2. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.
- I. Dissimilar Metal Protection: Alkali resistant bituminous paint conforming to AN-P 31, plastic separators, insulating tapes or manufacturer's standard, subject to Architect's approval.
- J. Finish:
1. Exposed Metal Surfaces: Manufacturer shall provide baked-on fluoropolymer coating having 70% Kynar 500 or Hylar 5000 resin, in custom color selected by Architect.
 2. Unexposed metal surfaces may remain uncoated.
- K. Sealants: As specified in Section 079200 – Joint Sealants.
- L. Glass & Glazing: Glaze with 1" insulating glass as specified under Section 088000 "Glazing".

2.4 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows:
1. Sash shall be tubular nom. 4-1/2" deep sections with nominal wall thickness of .125". Corners shall be mitered, reinforced with metal corner block, hydraulically crimped in eight places, and "cold welded" with epoxy adhesive.
 2. Sills: Each window shall rest on a thermally broken aluminum sub-sill extending from back of window frame to face of structural sill. Drip edge shall be formed to provide a positive draining drip and ends shall be fabricated to create water dams.

- B. Glaze aluminum windows in the field.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency:

1. Contractor shall Engage and pay a qualified testing agency to perform tests and inspections
2. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
2. Air-Infiltration Testing:
 - a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
 - b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.
3. Water-Resistance Testing:
 - a. Test Pressure: Eight (8) lbs/psf to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
 - b. Allowable Water Infiltration: No water penetration.
4. Testing Extent: One window (one W12) in location as shown on the drawings. Window shall be tested after perimeter sealants have cured.
5. Test Reports: Prepared according to AAMA 502.

C. Remove and replace noncomplying window and retest as specified above.

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

E. Prepare test and inspection reports.

F. Owner may have other random windows tested after they are completed in order to verify compliance with the above air and water resistant testing. Any windows that fail the tests will need to be corrected and retested at the Contractors expense.

3.4 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
 - 1. Keep protective films and coverings in place until final cleaning.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 085113

DIVISION 08 – OPENINGS

SECTION 087100 **FINISH 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.
- B. SUMMARY
 - 1. Door hardware for interior and exterior swinging doors
- C. Related Sections:
 - 1. Section 081113 "Hollow Metal Door Frames" for installation of hardware in doors frames including silencers.
 - 2. Section 081416 "Flush Wood Doors" for installation of hardware in new wood doors.
 - 3. Section 084113 "Aluminum Framed Entrance"

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Other Action Submittals:
 - 1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - a. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - b. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
 - c. Content: Include the following information:

- 1) Identification number, location, hand, size, and material of each door and frame.
 - 2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - 3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - 4) Fastenings and other pertinent information.
 - 5) Explanation of abbreviations, symbols, and codes contained in schedule.
 - 6) Mounting locations for door hardware.
 - 7) List of related door devices specified in other Sections for each door and frame.
2. Keying Schedule: Owner will complete all the keying to the cylinders. Provide (2) key blanks, of specified keyway, for each cylinder listed in the Door Hardware Schedule to the Owner.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
1. Warehousing Facilities: In Project's vicinity.
 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- B. Source Limitations: Obtain each type of door hardware from a single manufacturer.
- C. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- D. Accessibility Requirements: Comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design and ICC A117.1.
1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
 2. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
 3. Closers: Adjust door and gate closer sweep periods so that, from an open position of 90 degrees, the time required to move the door to a position of 12 degrees from the latch is 5 seconds minimum.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.6 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Two years from date of Substantial Completion, unless otherwise indicated.
 - a. Exit Devices: Three years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.
 - c. Bored Locksets: 7 years from date of Substantial Completion.
 - d. Hinges: Life of Building from date of Substantial Completion.

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 as follows:

1. Keyed Removal Mullion: As specified or Owner approved equal.
2. Locksets: Sargent or Owner approved equal.
3. Panic Hardware: Sargent or Owner approved equal.
4. Cylinders: As specified or Owner approved equal.
5. Closers: Norton or Owner approved equal.
6. All Other Hardware: As specified or Owner approved equal.

2.2 FABRICATION

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

2.3 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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Door Frames/Wood Doors & Aluminum Doors: 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 Door 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 type quantities indicated in door hardware schedule.
- D. Thresholds: Set threshold in full bed of sealant.
- E. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- F. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- G. Closers: All closers installed on wood doors shall be thru-bolted.

3.4 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.

3.5 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.

3.6 DOOR HARDWARE SCHEDULE

HARDWARE SET # 01: FOR USE ON DOOR # 160A

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONTINUOUS HINGE	14HD	628	MCK
1	EA	REMOVABLE MULLION	EL980	630	SAR
1	EA	PANIC HARDWARE	43-8804-FSW	32D	SAR
1	EA	PANIC HARDWARE	43-8810-FLW	32D	SAR
1	EA	RIM CYLINDER	34 SERIES	626	SAR
1	EA	MORTISE CYLINDER	40 SERIES	626	SAR
1	EA	ELECTRIC STRIKE	4850 POE	630	TRN
2	EA	CONCEALED OH STOP	1 SERIES	630	RIX
2	EA	SURFACE CLOSER	7500	689	NOR
2	EA	DOOR SWEEP	315CN	AL	PEM
1	EA	THRESHOLD	171A	AL	PEM

*WEATHER SEALS BY ALUMINUM DOOR MANUFACTURER.

*CARD ACCESS SYSTEM, READER, POWER SUPPLY, WIRING AND CONNECTIONS BY OTHERS.

*PROVIDE QUICK CONNECT/DISCONNECT AT TOP OF REMOVABLE MULLION FOR ELECTRIC STRIKE.

HARDWARE SET # 02: FOR USE ON DOOR # 160B

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	14HD	628	MCK
1	EA	PANIC HARDWARE	43-8810-EO	32D	SAR
1	EA	CONCEALED OH STOP	1 SERIES	630	RIX
1	EA	SURFACE CLOSER	7500	689	NOR
1	EA	DOOR SWEEP	315CN	AL	PEM
1	EA	THRESHOLD	171A	AL	PEM

*WEATHER SEALS BY ALUMINUM DOOR MANUFACTURER.

HARDWARE SET # 03: FOR USE ON DOOR #(S): 164

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONTINUOUS HINGE	14HD	628	MCK
1	EA	PANIC HARDWARE	NB-43-12-WD8610F-ET-L	32D	SAR
1	EA	PANIC HARDWARE	NB-43-12-WD8613F-ET-L	32D	SAR
1	EA	RIM CYLINDER	34 SERIES	626	SAR
2	EA	SURFACE CLOSER	7500	689	NOR
2	EA	KICK PLATE	K1050 10" X 2" LDW	630	ROC
2	EA	WALL MAG HOLDER	998	689	RIX
1	SET	SEALS	S88D	DKB	PEM
1	EA	ASTRAGAL	S771C7	DKB	PEM

*COORDINATE WITH ELECTRIC AND FIRE ALARM FOR WALL MAGNET. DOOR MUST RELEASE UPON ACTIVATION OF FIRE ALARM SYSTEM.

*TEMPLATE CLOSER OF INACTIVE LEAF FOR 180° OPENING.

HARDWARE SET # 04: FOR USE ON DOOR #(S) 162 & 163

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	14HD	628	MCK
1	EA	PRIVACY LOCK	28-10U65 LL	626	SAR
1	EA	CONCEALED OH STOP	1 SERIES	630	RIX
1	EA	SURFACE CLOSER	7500	689	NOR
1	EA	KICK PLATE	K1050 10" X 2" LDW	630	ROC
1	SET	SEALS	S88D	DKB	PEM

HARDWARE SET # 05: FOR USE ON DOOR # 161A

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	14HD	628	MCK
1	EA	CLASSROOM LOCK	28-10G37 LL	626	SAR
1	EA	SURFACE CLOSER	7500	689	NOR
1	EA	KICK PLATE	K1050 10" X 2" LDW	630	ROC
1	EA	WALL MAG HOLDER	998	689	RIX
1	SET	SEALS	S88D	DKB	PEM

*COORDINATE WITH ELECTRIC AND FIRE ALARM FOR WALL MAGNET. DOOR MUST RELEASE UPON ACTIVATION OF FIRE ALARM SYSTEM.

*TEMPLATE CLOSER FOR 180° OPENING.

HARDWARE SET # 06: FOR USE ON DOOR # 161B

EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	14HD	628	MCK
1	EA	CLASSROOM LOCK	28-10G37 LL	626	SAR
1	EA	ELECTRIC STRIKE	4100 POE	630	TRN
1	EA	CONCEALED OH STOP	1 SERIES	630	RIX
1	EA	SURFACE CLOSER	7500	689	NOR
1	EA	KICK PLATE	K1050 10" X 2" LDW	630	ROC
1	SET	SEALS	S88D	DKB	PEM

*CARD ACCESS SYSTEM, READER, POWER SUPPLY, WIRING AND CONNECTIONS BY OTHERS.

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. Glazing of exterior aluminum doors and frames.
 - 2. Glazing of interior wood doors.
- B. Related Requirements:
 - 1. Section 081416 "Flush Wood Doors" for glazing of new wood door
 - 2. Section 084113 "Aluminum Framed Entrances" for glazing of new aluminum entrances.
 - 3. Section 085113 "Aluminum Framed Windows" for glazing of new aluminum windows.

1.3 QUALITY ASSURANCE

- A. Comply with all pertinent codes and regulations, including the Consumer Product Safety Commission Safety Standard for Architectural Glazing Materials (16 CFR 1201) and the State of Illinois Safety Glazing Materials Act.
- B. Comply with all pertinent recommendations in the Glazing Manual of the Flat Glass Marketing Association.
- C. All glass shall bear glass manufacturer's label stating variety and grade.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturers' product data describing each type of glass and glazing item specified herein.
- B. Samples: Submit for Architect's review 2 samples, 6" square, of each type of glass required.
- C. Manufacturer's Instructions: Submit glazing gasket manufacturer's recommendations for each installation situation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For hollow metal door and borrowed lite frame assembly, for tests performed by a qualified testing agency.

1.6 WARRANTIES

- A. Installer shall guarantee installed work to be waterproof for a period of 5 years.
- B. Insulating glass units shall be warranted for 10 years against failure, including interpane dusting or misting and internal dew point rising above -50°F. Warranty shall provide for replacement of glass and glazing, including labor.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver glazing materials to job site in sealed containers with manufacturer's original labels attached to each piece of glass. Provide UL labels for fire rated glass. Provide cushions at edges to prevent impact damage.
- B. Store glass on edge, under cover and protect from staining.
- C. Avoid deformation of units. Protect faces from scratches and abrasion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Acceptable Manufacturers:
 - 1. Guardian.
 - 2. Pilkington.
 - 3. PPG.
 - 4. TGP (Fire Rated Glass)
 - 5. Best Glass (Fire Rated Glass)
 - 6. Saftifirst (Fire Rated Glass)
 - 7. or Owner approved equal during the bidding phase.
- B. Acceptable Glass Fabricators:
 - 1. Oldcastle Glass Co.
 - 2. Trulite Glass.
 - 3. Viracon.

2.2 GLASS

- A. Types and Qualities: Glass shall conform to ASTM C 1036-85 Standard Specification for Flat Glass and ASTM C 1048-87 Standard Specification for Heat Treated Flat Glass, as follows:

1. Insulating-Glass Unit Glass: ASTM E 2190, certified through IGCC as complying with requirements of IGCC. Basis of Design Glass listed - PPG products, equal by Guardian and Pilkington:
 - a. (Glazing Type GL-1): PPG 1" Insulated Solarban R100-Tempered:
 - 1.) 1/4" tempered on clear neutral reflective Low-E #2 surface.
 - 2.) 1/2" airspace with argon.
 - 3.) 1/4" clear tempered.
2. Fire Rated Glass (Glazing Type GL-2): Impact Safety Rated Clear Glass Ceramic: 5/16" thick, 1 1/2 hr fire rated; Basis of Design - "FireLiteplus" by TGP equal by Best Glass and Saftifirst.

2.3 Glazing Materials:

- A. Approved Manufacturers: Use products of the following:
 1. Tremco Manufacturing Co.
 2. G.E.
 3. Dap, Inc.
 4. Pecora Corp.
 5. Protective Treatments, Inc. (PTI).
 6. Vetrotech (Saint-Gobain).
- B. Setting Blocks: Neoprene, 70-90 durometer hardness, having proven compatibility with sealants used, width of rabbet less 1/16" by lengths sufficient for weight of glass supported.
- C. Spacers: Neoprene, 40-50 durometer hardness, having proven compatibility with sealants used.
- D. Compressible Filler Rod: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, proven to be compatible with sealants used, flexible and resilient, with 5-10 psi compression strength for 25% deflection.
- E. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.

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

3.2 PREPARATION

- A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings that are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used. Verify that weep holes are free of obstructions.
- B. Apply primer or sealer to joint surfaces wherever recommended by sealant manufacturer.
- C. Cut glass with smooth straight edges to full sizes required by openings. Do not attempt to cut, seam, nip or abrade glass that is tempered, heat strengthened, or coated.

3.3 INSTALLATION

- A. Glass:
 - 1. Set glass on setting blocks at quarter points, and fix without springing or inducing bowing. Install with proper bite and clearances all around.
 - 2. Glass having waviness shall be set with waves placed horizontally unless Architect directs otherwise. Lites viewed in series or as a group shall have uniform draw, bow and similar characteristics.
 - 3. Tempered glass having tong marks shall be installed so that tong marks are within rabbets at top of opening.

3.4 CLEANING

- A. All glass shall be left whole, free from checks or other defects, and cleanly washed inside and out and the building left ready for occupancy when directed by the Architect.
- B. Any defective glass that may appear after cleaning shall be removed and replaced with perfect glass.

END OF SECTION 088000

DIVISION 09 – FINISHES
SECTION 092900
GYPSUM BOARD SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide and install gypsum board partition on metal studs with acoustical insulation.
- B. Related Requirements: Section includes surface preparation and the application of paint systems
 - 1. Section 099113 "Painting" for finish painting of gypsum board surfaces.

1.3 ACTION SUBMITTALS

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

1.4 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.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, 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, 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.

PART 2 - PRODUCTS

2.1 FRAMING MATERIALS

- A. Metal Studs: Zinc coated steel channel studs, 20-gauge, 3-5/8" size except as required otherwise, conforming to ANSI/ASTM C 645 or GA 201 or GA 216.
- B. Runner Tracks:
 - 1. 20-gauge metal, matching stud width. Use tracks with minimum 1-1/4" leg when indicated or directed.
 - 2. Deflection Track: Provide for deck deflection by using "VertiTrack" manufactured by The Steel Network, Inc., tel: 888-474-4876 or approved equal, complete with manufacturer's patented fasteners having step bushings sized to the gauge of the studs.
- C. Reinforcing Strips: Electro-galvanized 20-gauge sheet steel meeting ASTM A 525, 8" wide.
- D. Angle Connectors: Galvanized 20-gauge sheet steel meeting ASTM A 525, formed into angle with 1-1/2" legs.

2.2 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.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board,: ASTM C 1396/C 1396M, Fire rated, tapered edge, conforming to ANSI/ASTM C 36 & C 1396, 5/8" thick:
 - 1. "Tough Rock Fireguard X Abuse Resistant Gypsum Board" by Georgia Pacific.
 - 2. "Gold Bond Hi-Abuse XP Gypsum Board" by National Gypsum Company.
 - 3. "Fiberock Abuse Resistant Interior Panels" by USG.
 - 4. Or Owner approved equal during the bidding phase.

2.4 FINISH MATERIALS

- A. Edge and Corner Reinforcement: Manufacturer's standard trim beads made of hot-dip galvanized steel with either knurled and perforated or expanded flanges, and beaded for concealment of flanges in joint compound. Vinyl trim NOT allowed.
 - 1. Corner Beads: Paper-faced heavy gauge metal or plastic with extra wide flanges, equal to USG "B1XW EL" or No-Coat "Ultracorner".
 - 2. Edge Beads: Paper-faced heavy gauge metal or plastic "L" type with extra wide flanges, equal to USG "B4 (1")" or No-Coat "L Trim.
 - 3. Control Joint Beads: Flexible expansion channel, such as USG #093 or Gold Bond ".093 Zinc Control Joint."

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Reinforcing Tape: Perforated joint reinforcing tape, paper or fiberglass, asbestos free.
- C. Joint Compound: Ready mixed all-purpose drywall joint compound, type and mix as required for conditions of humidity and temperature. Use topping type compound for finishing coats.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Fasteners: Screws meeting ASTM **C 954** and the following:
 - 1. For metal to metal framing: 1/2" long, Type S, shallow pan-head screws.
 - 2. For gypsum board: 1-1/4" Type S bugle-head screws.
 - 3. For tracks to concrete: Powder-actuated stud pins sized to penetrate concrete at least 1/2".
 - 4. For moving (deflection) joints: "VertiClip Step Bushing Fasteners" sized to match gauge of studs.
- C. Acoustical Sealant: One of the following:
 - 1. USG "Acoustical Sealant"
 - 2. W.W. Henry Co. "313 Sound Control Sealant"
 - 3. Tremco "Acoustical Sealant"
 - 4. Pecora "Acoustical Sealant BA-98"
 - 5. Norton "Norseal V730 and V740FR Acoustical Foam Tape"

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- 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 FRAMING INSTALLATION

- A. Partitions:
 - 1. Base Tracks: Install continuous tracks, straight and true, accurately aligned to the layout at tops and bottoms of studs. Secure tracks at each end and a maximum of 24" o.c. in between.

2. Studs: Set studs **plumb**, not more than 16" o.c. and not more than 2" from abutting walls. In each line of studs, face flanges all in the same direction.
3. Soffit Heights: All studs shall extend to heights as noted on Drawings.
4. Stud Securement: Studs shall engage both bottom and top runners. Secure studs to tracks with 2 screws at top and 2 screws at bottom, one each at both inside and outside flanges.
5. Top Track: Provide multiple runner track installation, at top of wall to accommodate deck deflection.
6. Stud Flanges: Do not cut to accommodate pipes, conduit, etc. without Architect's specific approval for each case.

B. Control Joints:

1. Placement: As indicated, consistent with lines of building spaces. Provide additional control joints in locations approved by General Contractor so that no expanse of wall exceeds 30 feet.
2. Framing: Frame each control joint in walls with 2 nearly abutting studs set back to back. Seal each side of space between studs with bead of sealant.

3.3 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. 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.
- C. 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.
- D. Form control and expansion joints with space between edges of adjoining gypsum panels.
- E. Fit gypsum panels around ducts, pipes, and conduits.
- F. Where partitions intersect structural members projecting below underside of 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. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

3.4 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior Type X gypsum board on Vertical surfaces unless otherwise indicated
- B. Single-Layer Application: Apply gypsum panels to supports with steel drill screws.
 1. On soffits, apply gypsum panels vertically (parallel 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.

3.5 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 cornerbeads at outside corners.

3.6 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 or beveled edges, 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 level 4 at panel surfaces that will be covered by finish painting and according to ASTM C 840:

3.7 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 blotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013
QUARRY TILE

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. At patch locations, remove existing quarry floor tile and base as required for clean level patch area and replace with new quarry floor tile flooring.
- B. Related Requirements:
 - 1. Section 017300 "Selective Demolition" for cutting and patching of existing base, floor and wall materials.
 - 2. Division 22 "Plumbing" for floor drain which must be adjusted and or replaced and other plumbing work affecting ceramic tile work.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's product descriptions of all materials as well as instructions for setting and grouting materials.
- B. Samples:
 - 1. Tile Colors: Match existing.
 - 2. Grout Colors: Submit manufacturer's sample to match grout color selected by Architect for his approval.
- C. Certificates: Provide manufacturer's TCA Master Grade Certificate for porcelain tile before starting work.

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. Supply extra 5% of total quantity of floor tile and base used. Place in clean marked cartons and deliver to Owner for Owner's maintenance use.

1.5 QUALITY ASSURANCE

- A. Installation Standards: Per recommendations contained in “Handbook for Ceramic Tile Installation,” latest edition, by Tile Council of America, Inc. (TCA).
- B. Installation Practices: Maintain as recommended by mortar and grout materials’ manufacturer.
- C. Tile Grades: Provide tile equal to or exceeding Standard Grade requirements of ANSI A137.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Deliver materials and store on site in original containers with seals unbroken and labels intact until time of use.
- B. Shade and Lot Number: Tile for each area of installation shall come from the same shade and lot number.

PART 2 - PRODUCTS

2.1 CERAMIC TILE

- A. Approved Manufacturers. Basis of Design: American Olean Unglazed Quarry Tile. Other quarry tile manufacturers such as DalTile, or Crossville products must meet or exceed American Olean specifications for each style, size and general color to be acceptable. Substitutions must be submitted 10 days prior to bid opening, for architect approval during bidding process.

1. Floor Tile: 6” x 6” Quarry Tile

- a. Patch to match existing. See plans for locations.
- b. Colors: As selected by Architect from manufacturer’s full range of colors to match existing.
- c. Provide metal floor transition strip, Jolly A100ATGB between corridor flooring, Cafeteria flooring, and quarry tile as needed. Skim and level tile for smooth transition. Based on field conditions, if a different Schluter transition is required, notify architect for approval and submit substitute sample for review.

2. Quarry Tile Base

CT-2: Bullnose height to match existing, 4” or 6” x 8”

- a. Patch areas of base as required.
- b. Provide Corner Trim with bullnose top and quarry tile transitions as required.

2.2 SETTING AND GROUTING MATERIALS

- A. Setting Material Floor Tile on Existing Slab-On-Grade: Dry-set mortar conforming to ANSI A 118.1.
- B. Setting Materials:
 - 1. Portland Cement: ASTM-C 150, Type I, gray or white, as required.
 - 2. Hydrated Lime: ASTM C 206 or C 207, hydrated Type S.
 - 3. Sand: ASTM C 144, graded for mortar or grout as required.
 - 4. Dry-set Mortar: ANSI A 118.1.
 - 5. Latex-Portland Cement Mortar: ANSI A 118.4.
 - a. Custom Building Products “VersaBond Fortified Thin-Set Mortar”.
 - b. Laticrete “254 Platinum”.
 - c. Mapei “PRP 315” with Kerabond or Keralastic mortar.
 - d. or Owner approved equal during the bidding phase.
- C. Ceramic Tile Grout: Polymer Modified Tile Grout conforming to ANSI A 118.7. Such as Mapei Ultracolor Plus or equal, as recommended by quarry tile manufacturer. Color to be selected by Architect from full range of options.
- D. Grout Sealer: Use one of the following, as recommended by grout manufacturer:
 - a. American Olean “Grout Sealer,”
 - b. TEC Inc. “Grout Guard Plus.”
 - c. or Owner approved equal during the bidding phase.
- E. Grout Sand: Use sand when required by installation directions specified under EXECUTION. Sand size shall be approved by Architect. Coarser sands may be used for quarry tile installations.
- F. Grout Sealer: TEC Inc. “GuardAll Grout and Stone sealer” or Owner approved equal during the bidding phase.
- G. Water: Clean and drinkable.

PART 3 - EXECUTION

- A. Removal of existing floor materials and mud bed at patch locations to create clean level patch:
- B. Floor Preparation:
 - 1. Clean existing concrete floor substrate of any material which would adversely affect the installation of the new quarry tile system.
 - 2. Light grind the cleaned concrete floor substrate as required to provide a satisfactory surface to properly install the quarry tile floor system.

3.2 INSTALLATION

- A. Quarry Tile Floors: Install on mortar beds in accordance with mud set TCNA method F111-15 Mortar bed thickness 2" maximum. See detail on page 62 of the Tile Council of North America's (TCNA) 2015 handbook.
 - 1. Setting bed mortar: Custom Building Products "Versabond" or other listed products.
 - 2. Grout: Gauge the grout with Custom Building Products "CEG 2000 Grout" or other listed products.
 - 3. Mixing Proportions and Procedures: In accordance with manufacturer of mortar additives.
- B. Floor Tile on Conventional Cement Mortar Bed: Shall be flush with adjacent floor finishes..
- C. Quarry Tile Base: Install over concrete block in accordance with ANSI Specification A 108.5 (Reference TCA detail W202, Latex-Portland Cement Mortar – with epoxy grout).
- D. Uniformity of Color: Set tile in each area using only tile from the same shade and lot number. Mix tiles from several boxes, and rotate the tiles to disguise variations and ensure a non-repeat appearance.
- E. Alignment of Floor Joints and Base Joints: Align so as to give straight uniform grout lines, both parallel and perpendicular to the walls. Align joints in base with floor joints.
- F. Alignment of Tile Base Joints: Align so as to give straight uniform grout lines, both horizontal and vertical. Align tile base joints with floor joints.
- G. Minimum Tile Sizes: Lay out all tile work so as to avoid cuts less than one-half tile in size.
- H. Control Joints: Provide control joint all around perimeters and as required to keep expanses of field tile from exceeding 12ft in length. Expansion and control joints in substrates must be continued through tile work.

3.3 CLEANING

- A. General: Upon completion of placement and grouting, clean all new porcelain tile floor so they are free of foreign matter. Use neutral cleaner.
 - 1. Unglazed Tile: May be cleaned with acid solutions only when permitted by tile and grout manufacturers' printed instructions, but no sooner than 14 days after installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning. Do not use acid solutions in rooms or areas where stainless steel occurs.
 - 2. Results Required: Leave the finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective tile work.

3.4 PROTECTION

- A. Floor Grout: Shall be sealed after grout is applied. Use grout sealer as recommended by quarry tile manufacturer.
- B. Protective Coating: When recommended by the tile manufacturer, apply protective coat of neutral protective cleaner to completed tile floors & base.
- C. Protective Covering:
 - 1. Protect installed tile floors with kraft paper or other heavy covering during the construction period to prevent damage and wear.
 - 2. Before final inspection, remove protective coverings and rinse neutral cleaner from all tile surfaces.
- D. Foot and Wheel Traffic: Prohibit all traffic from using tiled floors for at least 3 days, preferably 7 days.

END OF SECTION 093013

DIVISION 09 – FINISHES
SECTION 095123
ACOUSTICAL 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:

- 1. Acoustical tiles for ceilings.
- 2. Acoustical ceiling suspension systems.

- B. Related Requirements:

- 1. Section 211300 "Fire Detection & Alarm System, Addressable"
- 2. Section 230000 "Air Supply, Dist., Vent., & Exhaust Systems"
- 3. Section 265100 "Interior Lighting"

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, submit product data from manufacturer's brochures describing each of the products to be used.

- B. Samples:

- 1. Submit samples of acoustical materials and suspension system members for review before ordering any materials.
- 2. For each exposed product and for each color and texture specified, 6-inches- in size.

- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

- 1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
- 2. Exposed Moldings and Trim: Set of 6-inch long Samples of each type and color.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Maintenance Stock: Furnish not less than 1 unopened bundle of each type of acoustical ceiling units for future maintenance. Distribute quantities in approximate proportion to the different types of units installed. Deliver to location on site designated by Owner.

1.5 QUALITY ASSURANCE

- A. Qualifications of Installers: Use only personnel who are thoroughly trained and experienced in the erection of the selected systems.
- B. Installation Standards: Comply with recommendations of the current Cisca “Ceiling Systems Handbook” except as specified otherwise hereinafter, and maintain a copy of the handbook at the site for Architect’s inspection while work of this Section is being accomplished.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, 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 tiles, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.8 WARRANTIES

- A. Ceiling Panels: Where so specified herein below, products shall be warranted to be free from defects in materials and workmanship for a period of 10 years from date of purchase when subjected to the conditions of temperature and humidity specified.

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: 450 or less.

2.2 ACOUSTICAL TILES, GENERAL

A. Source Limitations:

1. Acoustical Ceiling Tile: Obtain each type from single source from single manufacturer.
2. Suspension System: Obtain each type from single source from single manufacturer.

B. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.

C. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.

2.3 ACOUSTICAL TILES

A. Acoustical Ceiling Panels Types:

1. Type ACT-1: 24" x 24" x 5/8", lay-in panels; Accepted Product, Armstrong No. 1717 Fine Fissured™ or approved equal.
2. Type ACT-2: 24" x 24" x 5/8", lay-in panels; Accepted Product, Armstrong No. 607 non-perforated "Ceramaguard" or Owner approved equal during the bidding phase. Match existing.

2.4 PERIMETER TRIM

A. Approved Manufacturer: Armstrong Axiom Classic. Extruded Aluminum. Follow manufacturers full specifications and product data sheet. See Drawings. Select color from full range of options. Or approved equal.

2.5 METAL SUSPENSION SYSTEMS

A. Exposed Grid Ceiling Suspension Systems: Rigid metal, complying with ASTM C 635, intermediate duty system, consisting of interlocking cross tees and main tee runners (not less than .020" thick) made from cold rolled, zinc-bonded or electro-galvanized steel and creating flush joints at intersections.

1. Components shall support items penetrating the ceilings, including light fixtures and HVAC outlets/inlets.
2. Tee sections shall be double web type with a 1" exposed flange cap finished in baked white enamel.
3. Hold-Down Clips (for use where specified): Manufacturer's standard electro-galvanized steel hold-down clips.
4. Use USG "Donn DX" suspension systems for 24" x 24" grids or approved equal.

- B. Wall Molding: Angle type, hemmed metal molding with finish to match grid system.
- C. Hanger Wire: Pre-stretched, galvanized, soft-annealed mild steel wire conforming to ASTM A 641, 12-gauge.
- D. Carrying Channels (for bridging between structural members overhead): Hot or cold rolled steel 1-1/2" channels painted with black asphaltic rust inhibitive paint and weighing not less than 475 lbs. per 1000 lineal feet.
- E. Tie Wire for Attachment of Channels to Structure: Galvanized steel wire conforming to ASTM A 641, 16-gauge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine acoustical tiles before installation. Reject acoustical tiles 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 tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. General: Install acoustical panel ceilings to comply with ASTM C 636, 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. 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.
 - 3. 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.

4. 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.
 5. 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.
 6. 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.
 7. Do not attach hangers to steel deck tabs.
 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 tile ceiling area and where necessary to conceal edges of acoustical tiles.
1. 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 tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches o.c.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095123

DIVISION 09 – FINISHES
SECTION 096519
RESILIENT FLOORING & BASE

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. Preparation of existing concrete floors to receive Quartz Tile, Rubber Tile flooring and wall surface to receive new rubber base including moisture testing of concrete floors, documentation of tests.
- 2. Moisture Mitigation is required by contractor based on test results.
- 3. All flooring areas within project shall receive skim coat.
- 4. Installation of new Quartz tile, Rubber Tile flooring, Transitions/Accessories, and Rubber Base.
- 5. Stair treads, Risers, Stringers.
- 6. Resilient floor trim accessories.

- B. Related Requirements:

- 1. Section 033000 "Cast-In-Place Concrete" for new slab-on-grade.
- 2. Section 042000 "Unit Masonry" for CMU walls.
- 3. Section 099100 "Gypsum Board Systems" for gypsum board walls.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Submit 3 sets of samples of each type, color and finish of resilient flooring, base and accessory required.
 - 1. Provide manufacturer's standard boxed selection kit for flooring and 6" long samples of accessories.
 - 2. Include full range of colors and pattern variations.
 - 3. Upon request, provide 12" square samples of the flooring colors selected from the sample kit.
- C. Submit a letter from the resilient flooring manufacturer that the adhesive proposed to be used is compatible with the resilient flooring.

1.4 QUALITY ASSURANCE

- A. Manufacturers: Wherever possible, provide resilient flooring, adhesives and accessories produced by a single manufacturer.
- B. Flammability: Provide only materials, including adhesives, which will produce an installation having:
 - 1. Critical Radiant Flux of not less than 0.45 watts per cm² when tested per ASTM E 648.
 - 2. Smoke Density no greater than 450 when tested per ASTM E 662.

1.5 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. Furnish to the Owner in unopened boxes for future maintenance not less than 3% of each major kind and color of floor tile installed. For accent colors, furnish not less than 10% of each color.
 - 2. Furnish not less than 10 linear feet of each type, color, pattern, and size of rubber base installed.
 - 3. Stair Treads: Furnish to Owner in labeled boxes for future maintenance loose stair treads not less than 5% of each color of stair tread installed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient base and installation materials in dry spaces protected from the weather.
- B. Install resilient base after other finishing operations, including painting, have been completed.

1.7 WARRANTY

- A. Provide a 2 year installation warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acceptable Products & Manufacturers:
 - 1. Floor Covering: Basis of Design: Quartz Tile, Mosaic Collection by UpoFloor 24" x 24". Quartz tile materials manufactured by Altro products also acceptable. Quartz tile manufacturers must meet or exceed UpoFloor specifications including type, size, and general color options to be acceptable. Substitutions must be submitted 10 days prior to bid opening, for architect approval during bidding process.

2. Floor Covering: Quartz Tile by UpoFloor 24" x 24" x 2mm thickness. Mosaic Collection. Colors listed below are to be field verified by architect. See plans for pattern/placement. Or Owner approved equal during the bidding phase.
 - a. QT- 1 – 9321, QT- 2 – 9324, QT-3 – 6352
 - 1.) Adhesive: Upofloor 5900
 3. Floor Covering: Rubber Floor Tile at Ramps. 24" x 24" x 1/8" thickness. Rubber floor tile by Johnsonite, Hammered texture, Solid color to be selected from full range of options. Provide manufacturers recommended adhesive. Or Owner approved equal during the bidding phase.
- B. Acceptable Wall Base Products & Manufacturers: Rubber material complying with ASTM F 1861, Type TS, 6" high (refer to drawings for locations), 1/8" .080" thick, Style B coved profile, furnished in rolls.
1. Acceptable Manufacturers: Basis of Design – Johnsonite. Rubber Base manufactured by Flexco or Roppe must meet or exceed Johnsonite specifications to be acceptable or Owner approved equal during the bidding phase.
- C. Stair Treads, Risers and Stringers:
1. Rubber stair tread with integrated riser units complying with ASTM F-2169. Units shall have square nose with 2 wide contrasting color grit tape insert the full length of tread. Manufacturer shall be Johnsonite Model VIHTR (Visually Impaired) in Hammered Surface, 2" hinged, square nose configuration, profile and size to match existing field condition, solid color to be selected from full range of options. Or approved equal.
- D. Edge Transitions: Johnsonite Slimline products, Or approved equal. Include manufacturers recommended transition strip adhesives and accessories.
1. Existing VCT to Quartz: Verity transition requirement on site. May use Slimline.
 2. Rubber Floor Tile to Quartz: Johnsonite Slimline SLT-XX-C
 3. Rubber Floor Tile to Walk off Carpet: SLT-XX-A
- E. Adhesives: Water-resistant type recommended by resilient-product manufacturer as listed above, for resilient products and substrate conditions indicated. Verify Internal Relative Humidity requirements. Or approved equal complying with manufacturer's recommendations, letter indicating approval from manufacturer required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of rubber base.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog, installation instructions.
- D. Verify that wall surfaces to receive rubber base are free of bond breakers. Report to Contractor in writing any surfaces unsuitable to develop a permanent bond.
- E. Start of flooring and base preparation and installation will indicate acceptance of subfloor and wall conditions and acceptance of full responsibility for completed work.
- F. Verify that building air temperature and relative humidity are within manufacturers' recommended limits and that concrete floor temperatures are within 20°F of surrounding air temperatures.
- G. Verify that moisture contents of concrete slabs in new and existing areas are within recommended limits of flooring and adhesive manufacturers, as determined by a 72-hour sodium-chloride kit test per ASTM F 1869.
 - 1. Moisture meter readings and plastic mat test results will not be accepted as conclusive.
 - 2. Perform tests in areas where drying is most restricted but not closer than 5ft to a perimeter, performing at least 2 tests for the first 2,000 SF and an additional test for each additional 1,000 SF.
 - 3. Provide relative humidity tests based on at least 2 tests for the first 2,000 SF and an additional test for each additional 1,000 SF. Cost for testing is paid for by the flooring contractor.
- H. If Moisture readings are higher than recommended limits in new concrete slabs, contractor is responsible to provide moisture mitigation. If moisture readings are higher than recommended limits in existing concrete, contractor to provide moisture mitigation as a change order to the project.

See Spec Section - 035420 Moisture Mitigation Underlayment.

Contractors option: If Moisture readings are high in areas to receive Quartz tile, UpoFloor Quartz tile offers UpoFloor 200 Resilient Formula Aerosol spray adhesive for use up to 95% Internal Relative Humidity. Follow Manufactures Product Data Sheet/Installation guidelines & instructions. Subfloor must be vacuumed and damp mopped to ensure there isn't any dirt or dust left behind to interfere with Aerosol adhesion.

- a. Altro Quartz tile does not offer a high moisture level adhesive. They maintain a less than 85% IRH requirement.
 - b. Johnsonite does not offer a high moisture level adhesive for their rubber tile and treads. The moisture tolerance for Johnsonite 965 adhesive with Rubber tile is less than 85% IRH when the slab is tested with insitu-probes or 7Lbs when testing with Calcium Chloride.
- I. Skim Coat all areas to receive new flooring, using Schonox SL Portland Cement Based compound, following manufacturer's specification section, recommended installation and product data sheet. Or Owner approved equal during the bidding phase.

Note: All areas treated for Moisture Mitigation are to receive 1/8" of Schonox US leveler as a skim coat, or equal, in lieu of Schonox SL, as a compatible porous product approved by adhesive manufacturer for use with the proposed adhesive and which will not react with other floor materials.

- J. Use Schonex US self leveling compound as required using manufacturers specification section, recommended installation and product data sheet. Or Owner approved equal during the bidding phase.

3.2 PREPARATION

- A. Should excessive alkalinity be discovered, treat the affected areas with a water solution containing 10% muriatic or acetic acid and allow solution to dry.
- B. Prepare walls and cabinet bases to receive new wall base as required. Remove bond breakers down to a solid, durable substrate. Fill voids with approved filler.
- C. Vacuum the floor just before application of flooring, until clean and free of dust.

3.3 RESILIENT FLOORING INSTALLATION

- A. Comply with manufacturer's written instructions for installing vinyl composition tile.
- B. Install flooring after building finishes, including painting, have been completed and permanent heating system is operating.
- C. Place flooring with adhesive cement in strict compliance with manufacturer's recommendations, including open time. Tightly cement resilient flooring to floor, leaving an installation without open cracks, voids, raised or puckered joints, telegraphing of substrate imperfections or adhesive spreader marks, or other surface imperfections.
- D. Butt the flooring tightly to vertical surfaces and edgings. Scribe as necessary around obstructions to produce neat joints, laid tight, even, and straight.
- E. Extend flooring into toe spaces, door reveals, and similar spaces.
- F. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of the room are of equal width. Adjust as necessary to avoid use of tiles less than 6" wide at room perimeters. Lay tile square to room axis, unless otherwise shown.

- G. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged. Lay tile with grain in basket-weave pattern.
- H. Install tile manufacturer's recommended **PORTLAND CEMENT BASED** floor patch filler material to raise level of tile flush with other adjacent floor materials.
- I. Install edging strips at all unprotected edges of flooring. Place resilient edge strips tightly butted to flooring and secure with adhesive.

3.4 RUBBER BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing rubber base.
- B. Apply rubber base to walls, in rooms and areas where base is required.
- C. Install rubber base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere rubber base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch rubber base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of rubber base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

3.5 STAIR TREAD INSTALLATION

- A. Install stair treads/risers in single pieces, from stair stringer to stringer, except as approved otherwise by Architect.
- B. Use Johnsonite 930 Nose Epoxy and 965 adhesive for Stair Treads/Risers with Nose Stick - RH of 85%. Take special care to aggressively adhere nosings.

3.6 ADJUSTMENTS

- A. Tiles that have not "seated" in level plane with surrounding tile shall be removed and cleaned and re-set with new adhesive.
 - 1. Misaligned joints in base shall be reset or replaced with new, properly fitting pieces as required.
 - 2. Any resilient base that shrinks on the wall within 1 year of installation shall be replaced at no charge to the Owner.
- B. Tile showing broken corners or fracture lines entirely across their surfaces shall be warmed, removed and new tile of same color, etc., substituted. Repair tile showing minor breaks and fractures.

3.7 CLEANING

- A. Cleaning: Remove temporary coverings and protection of adjacent work areas.
 - 1. Repair or replace damaged installed products.
 - 2. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.

3.8 PROTECTION

- A. Protect vinyl composition tiles and rubber base from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096519

SECTION 096813
CARPET TILE

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 modular carpet tile.
 - 1. Preparation of new concrete floors to receive new carpeting and wall surface to receive new rubber base to include:
 - a. Moisture testing of concrete floors.
 - b. Documentation of tests.
 - c. Moisture Mitigation is required by contractor based on test results.
 - d. All flooring areas within project shall receive skim coat.
 - 2. Walk off Carpet Tile
 - 3. Carpet edging and other accessories.
- B. Related Requirements:
 - 1. Section 096513 "Resilient Flooring and Base" for resilient wall base, transitions and accessories installed with carpet tile.

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications: Carpet Installation Company: Shall be certified by carpet manufacturer and shall have at least 5 years' satisfactory experience in the installation of carpets of the types specified. Only qualified and experienced carpet mechanics working under proper supervision shall be employed on the project.
- B. Flammability Test Requirements: Provide only materials, including adhesives, which will produce an installation having a Critical Radiant Flux of not less than 0.45 watts per square centimeter when tested by the Flooring Radiant Panel Test.
- C. Adhesive Test Requirements: The suitability of the adhesive will require testing as further specified herein after under EXAMINATION.

1.4 SUBMITTALS

A. Certifications:

1. Manufacturer shall submit certification that materials manufactured are in accordance with materials herein specified. Include certified laboratory test report for flammability requirements.
2. Manufacturer shall submit certification that Installer is a factory approved installer.

B. Samples: Submit samples of carpets. Label samples, stating color or shade, location in which they are to be used and manufacturer's name. Carpet samples shall be at least one tile per pattern.

C. Maintenance Supply: Provide 5% maintenance stock of each type of carpet used. Package unused carpet tiles in boxes suitable for preservation of carpet in long term storage. Deliver packaged tiles to location in building designated by Owner

D. Maintenance Manuals: Obtain from manufacturer and submit for Owner's use, 3 copies of manufacturer's complete maintenance recommendations for carpet(s) installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery and installation of carpeting shall be coordinated with completion schedule for the various areas.

B. Carpet shall be stored away from construction activities and shall be protected against moisture, dust and vermin.

C. Installation shall not begin in any area until painting and ceiling work for that area have been completed.

1.6 GUARANTEES

A. Guarantees shall start at an adjusted date if carpet is installed after the date of Substantial Completion.

B. Provide a 2 year installation warranty in addition to other warranties standard to the manufacturer for the carpets selected.

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Acceptable Manufacturer. Basis of Design: Tandus Abrasive Action 02578 Modular. Carpet Tile manufacturers must meet or exceed Tandus Abrasive Action specifications including type, size, and general color options to be acceptable. Substitutions must be submitted 10 days prior to bid opening, for architect approval during bidding process.

1. Carpet Tile – CPT-1: Color: Winter Grey 19103

a. Carpet shall be installed unidirectional

2.2 ACCESSORIES

A. Carpet:

1. All seam tape, edge sealers and other accessories shall be as recommended by the carpet manufacturer.
2. Adhesives: Use Manufacturers recommended adhesive. C-EX - Water based, strippable, waterproof type, compatible with substrate and carpeting materials, as recommended by carpet manufacturer. Verify Internal Relative Humidity requirements. Or approved equal complying with manufacturer's recommendations, letter indicating approval from manufacturer required

B. Edge Transition Strips, and Rubber Base, including adhesive and accessories. Color/Finish to be selected. See Section 096513 "Resilient Flooring and Base"

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that building air temperature and relative humidity are within manufacturers' recommended limits and that concrete floor temperatures are within 20°F of surrounding air temperatures.
- B. Provide required floor Moisture Vapor Emission Rate (MVER) testing, pH testing and Relative Humidity testing prior to flooring installations. MVER Testing (ASTM F-1869-10), RH Testing (ASTM F-2170 -10), pH Testing (ASTM F-710-10). A minimum of one test per 1,000 square feet of flooring space is required. Check manufacturer's full requirements and warranties prior to installation.
- C. Verify that moisture contents of new concrete slabs are within recommended limits of flooring and adhesive manufacturers, as determined by a 72-hour sodium-chloride kit test per ASTM F 1869.
 1. Moisture meter readings and plastic mat test results will not be accepted as conclusive.
 2. Perform tests in areas where drying is most restricted but not closer than 5ft to a perimeter, performing at least 2 tests for the first 2,000 SF and an additional test for each additional 1,000 SF.
 3. Provide relative humidity tests based on at least 2 tests for the first 2,000 SF and an additional test for each additional 1,000 SF. Cost for testing is paid for by the flooring contractor.
- D. If Moisture readings are higher than recommended limits in new slabs, moisture mitigation is required. Notify Architect. If Moisture readings are higher than recommended limits in new concrete slabs, the General Contractor is responsible to provide the moisture mitigation. If moisture readings are higher than recommended limits in existing concrete, contractor to provide moisture mitigation as a change order to the project.
 - a. See Spec Section - 035420 Moisture Mitigation Underlayment.

- E. Before beginning work to lay new carpet, examine all surfaces over which work is to be applied. Report to the Architect in writing any surface defects and conditions that are unsuitable to receive work.
- F. Starting of work shall be construed as acceptance of the suitability of the surfaces to receive work. Remove and replace at no charge to Owner all work under this Section which may require removal in order to correct defects caused by insufficient examination and preparation of the substrates.

3.2 PREPARATION

- A. Should excessive alkalinity be discovered, treat the affected areas with a water solution containing 10% muriatic or acetic acid and allow solution to dry.
- B. Skim Coat entire area to receive new flooring using Schonox SL Patch Portland Cement Based compound following the manufacturers full data sheets and specifications

Note: All areas treated for Moisture Mitigation are to receive 1/8" of Schonox US leveler as a skim coat, or equal, in lieu of Schonox SL, as a compatible porous product approved by adhesive manufacturer for use with the proposed adhesive and which will not react with other floor materials.

- C. Fill saw cut joints, construction joints, expansion joints, cracks and depressions with flexible vinyl filler or portland cement product as required to prevent show-through.
- D. Clean and prepare to a satisfactory condition all surfaces scheduled to receive carpeting.
- E. Check the match of carpet tiles to ensure that there is no visible variation between dye lot runs.

3.3 INSTALLATION

- A. Carpet Tiles:
 - 1. Glue vinyl backed carpet tile directly to floor. Use manufacturer's recommended application pattern for adhesive and cover floor evenly with adhesive.
 - 2. Follow manufacturer's recommended installation for fillers.
 - 3. Install transition strip at all exposed edges of carpet and where carpet abuts any other floor material, except at ceramic tile, in which case, the edging will be provided with the tile. Edging shall be one continuous piece at doors and wherever standard lengths permit. Securely fasten edging to floors.
 - a. When carpet ends at doorway and door swings over carpet, place carpet under door (but not beyond door) and finish carpet with nose of edge strip aligned with the edge of the stop on the door frame.
 - b. When carpet ends at doorway and door swings away from carpet, place carpet up to face of door and finish carpet with edge strip having its nose aligned with the edge of the stop on the door frame.

3.4 PROTECTION

- A. No furniture or other heavy objects shall be placed on carpet until the adhesive has cured.
- B. Protect carpet after installation against stains and accumulations of dust and debris.

3.5 CLEANING AND PROTECTION

- A. The completed installation shall be free of scraps, carpet ripples and puckers. Clean up all dirt and debris. Clean all spots with proper remover. Remove loose threads; reweave any ravels at seams or edges.
- B. Damage: Repair any damage to existing paintwork, millwork, walls, doors, floors, etc., caused by carpet installation.
- C. Upon completion of the installation remove all waste, excess materials, protective coverings, tools and equipment.
- D. Carefully and thoroughly vacuum clean all new installed carpet to Owner's satisfaction. Do not begin vacuuming until perimeter resilient base has cured at least 10 days. When schedules allow, do not begin vacuuming until 14 days after installation of resilient base.

END OF SECTION 096813

SECTION 099113
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 finish painting of:
 - 1. New and existing hollow metal doors and frames.
 - 2. New and existing CMU block.
 - 3. New drywall soffits.
 - 4. New steel lintels.
 - 5. New Handrails
 - 6. New Louvers.
 - 7. Existing hollow metal doors an frames.
- B. Related Requirements: Section includes surface preparation and the application of paint systems
 - 1. Section 017300 "Execution" for patched and existing adjacent existing masonry wall to be finish painted in field to be finish painted in field.
 - 2. Section 055000 "Metal Fabrications" for pipe and guard rails to be finish painted in field.
 - 3. Section 081113 "Hollow Metal Frames" for door to be finish painted in field frames.

1.3 SUBMITTALS

- A. Product Data: Submit for Architect's review on all products to be used. List each material and cross-reference it to the specified paint and finish system and application. Identify by manufacturer's catalog number and general classification.
- B. Color Samples: When so requested, submit samples of each finish and topcoat color for Architect's review. Also, submit samples on portions of work at the site as directed by Architect, not less than 4ft x 4ft size.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Maintenance Supply: Deliver to Owner in unused containers 1 gallon of each type and color of paint used on the Project. Mark each container with color and room names/numbers where paint was used, without obscuring manufacturer's label. Deliver these containers to place on site designated by Owner.

1.5 QUALITY ASSURANCE

- A. Comply with State of Illinois Regulations (effective date July 1, 2009) regarding VOC (Volatile Organic Compounds).

1.6 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 (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Approved Manufacturers: Basis of Design - Sherwin Williams paints as listed. Paint materials manufactured by Pittsburgh Paints PPG or Benjamin Moore products must meet or exceed SW specifications for each paint type listed to be acceptable.
- B. Approved Products: Manufacturer's products listed hereinafter in the Painting Schedule represent types and grades required. Or Owner approved equal during the bidding phase.
- C. Grades: Materials not displaying manufacturer's identification as a best-grade product will not be acceptable.
- D. Thinners: Paint manufacturer's preferred solvent.
- E. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Conditions: Applicator must examine areas and conditions under which painting work is to be done and shall notify Contractor in writing of conditions detrimental to proper and timely completion of work.
- B. Moisture Contents: Do not apply coatings to surfaces where electronic moisture meter indicates values above 12%, except that for wood, moisture content may be not exceed 15%.
- 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.
- 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.

3.3 REPAINTING EXISTING PAINTED SURFACES

- A. Surface Preparation:
 - 1. Do not paint existing surfaces until any items attached to existing surfaces and not scheduled for painting (e.g. door hardware) have been removed. (The trade removing the attachments shall replace them to their original positions after painting is complete.).

2. Wash surfaces to be repainted.
3. Remove all loose, blistered, cracked or otherwise defective paint and varnish. Sand surfaces smooth, free of depressions. Cut out and fill cracks or other defects to match adjoining surfaces.

3.4 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 entire exposed surface of door frames.
 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. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.5 FIELD QUALITY CONTROL

- A. Architect's Inspection: All work where a coat of material has been applied must be inspected and approved by Architect before application of succeeding specified coat; otherwise no credit for the coat applied will be given and the work in question shall be recoated.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.6 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.

3.7 PAINTING SCHEDULE

- A. New and Existing Interior Hollow Metal Doors and Frames, Handrails, Removable Mullions, Louvers, and Lintels
 - 1 coat - S-W Pro-Industrial ProCryl Universal Acrylic Primer, B66-310,
 - 2 coats - S-W Pro Industrial Precatalyzed Waterbased Epoxy eg-shel K45-150
- B. Existing and New Concrete Masonry Units (CMU).
 - Block filler - S-W Prep Rite Int/Ext Block Filler
 - 2 coats - S-W Pro Industrial Precatalyzed Waterbased Epoxy eg-shel K45-150
 - Note: Block filler applied by airless spray and back rolled to fill all voids, at max. s.f./gal. rate recommended by manufacturer for 16 mil thickness.
- C. New Gypsum Board Soffits.
 - 1 coat S-W ProMar 200 Interior Latex Primer, B28W601
 - 2 coats S-W Pro Industrial Precatalyzed Waterbased Epoxy eg-shel K45-150
- D. Exterior Steel Lintels and Steel Supports for Enclosures.
 - 1 coat - S-W Pro Industrial ProCryl Universal Metal Primer B66-310
 - 2 coats - S-W Pro Industrial Acrylic Semi-gloss B66-650
- E. New Exterior Railings.
 - 1 coat - S-W Pro Industrial ProCryl Universal Metal Primer B66-310
 - 2 coats - S-W Pro Industrial Acrylic Semi –Gloss B66-650
- F. Existing Interior Hollow Metal Doors and Frames.
 - 2 coats - S-W Pro Industrial Precatalyzed Waterbased Epoxy eg-shel K45-150

END OF SECTION 099113

SECTION 104413
FIRE EXTINGUISHER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Fire extinguisher cabinets & fire extinguishers.

- B. Related Requirements:

- 1. Section 042000 "Unit Masonry" for wall surface.
 - 2. Section 091900 "Gypsum Board Systems" for wall surface.
 - 3. Section 099000 "Painting" for finish painting of F.E. cabinet.

1.3 SUBMITTALS

- A. Manufacturer's Data: Submit 2 copies of manufacturer's specifications and installation instructions for each type of unit specified. Indicate rough opening sizes, anchorages and accessory items.
- B. Submit samples of lettering for cabinet front. Indicate text, letter style, size, color and location.

1.4 QUALITY ASSURANCE

- A. Standards: Comply with the State of Illinois Accessibility Code and Americans with Disabilities Architectural Guidelines (ADAG).
- B. Certifications: Fire extinguishers shall be delivered with certification denoting that they have been inspected for serviceability by a certified fire equipment inspector within the previous 30 days.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHER CABINETS

A. Acceptable Models & Manufacturers:

1. Architectural Series Model No. 2409-R4 (Non-Rated) by Larsen's Manufacturing.
2. Clear Vu Series Model No. 1516 (Non-Rated) by J. L. Industries.
3. Alpine Series by Nystrom

B. Type: Semi-recessed complying with ADA requirements.

C. Cabinet Construction:

1. Cabinet Box: Steel with baked enamel finish inside and outside. Inside dimensions approximately 24"H x 9-1/2"W x 6"D (inside box dimensions).
2. Wall Rough Opening: 25" H x 10 1/2"W x 3"D.
3. Hinges: Recessed or continuous.
4. Door: Steel panel with full-height duo type tempered glass cutout, full-size baked enamel finish, white color.
5. Door Handle: Applied type, as selected by Architect from manufacturer's options, including factory finish.
6. Door Frame: Rolled edge design, of steel, factory baked enamel painted white.
7. Identification: Cabinet shall bear the words "FIRE EXTINGUISHER" written vertically, with upright letters stacked on top of each other, on metal part of door panel in manufacturer's standard typeface selected by Architect. Words shall be in red letters.

2.2 FIRE EXTINGUISHERS

- A. Type: 10 lbs capacity, multi-purpose type for A/B/C Class fires, U.L. listed, fully pressurized, with sight gauge, factory charged.
- B. Placard: Include rigid, permanent sign for mounting next to fire extinguisher stating that extinguisher shall not be used until fire suppression system has been activated.
- C. Serviceability Inspection: Within 30 days prior to delivery to site, each fire extinguisher shall have been inspected for serviceability by a certified fire equipment inspector and shall bear the inspector's current tag or equivalent mark upon delivery.
- D. Quantities: Furnish 1 fire extinguisher for each fire extinguisher cabinet.

PART 3 - EXECUTION

A. INSTALLATION

- B. General: Install surface mounted cabinet units in accordance with details on Drawings and recommendation of manufacturer.
- C. Mounting Heights: Locate bottom of cabinet as shown on Drawings or as directed by Architect except as otherwise required by ADA Standards

END OF SECTION 144113

SECTION 114000**FOODSERVICE EQUIPMENT****April 3, 2017****SECTION 114000 – FOODSERVICE EQUIPMENT****PART 1 – GENERAL****1.1 WORK INCLUDES**

- A. The work referred to in this section consists of furnishing all labor and material required to provide and deliver all equipment hereinafter specified into the building, uncrate, assemble, hang, set in place, level, and completely install, exclusive of final utility connections.
- B. Coordinate but do not install (unless specifically directed to do so in the technical specifications) Owner and Vendor-supplied equipment noted on the drawings or in the specifications as NIKEC. Show on roughing in plans the sizes, utilities, and other requirements as furnished in the Specifications, by Owner or appropriate supplier in submittals as if the equipment is contractor furnished.
- C. Coordinate and show sizes, utilities, and other requirements as determined by physical inspection for equipment noted as existing to be reused. Include costs for marking, removing, storing, cleaning, redelivering and installing such equipment. All requirements within the project manual apply to reused equipment except warranty as if contractor furnished including but not limited to code compliance and accessories necessary to conform with the new application.

1.2 SUBMITTALS

- A. Upon award of Contract, furnish the Architect with reproducible copies of the following drawings, in accordance with the approved project schedule, which shall be made on sheets equal in size and matching the bid set drawing size. Reproduced copies of bid documents will not be accepted for this purpose in any fashion.
 - 1. Equipment specified for fabrication shall be detailed and fully dimensioned to a minimum scale of $3/4" = 1'-0"$ (1:20) for plan and elevation views and $1-1/2" = 1'-0"$ (1:10) for sections.
 - 2. Prepare separate electrical and mechanical dimensioned rough-in drawings at $1/4" = 1'-0"$ (1:50) showing exact point of penetration of floors, walls, and ceilings for all services required to operate the equipment that the Contractor shall furnish, including the requirements for Contractor supplied and installed refrigerant and beverage piping line runs. These drawings shall also show exact locations of final connections to equipment. Indicate floor drains, floor sinks, receptacles, lights, and other special conditions related to the equipment known to the Contractor but provided under other Sections.
 - 3. Dimensioned drawings shall be submitted showing the location and size of all bases, depressions, grease interceptors, special height walls, openings in walls for equipment or operations, and critical dimensions, etc. Drawings shall be drawn to a scale of not less than $1/4" = 1'-0"$ (1:50).
- B. Manufacturers' Data: Upon award of Contract, submit bound copies of Manufacturers' Illustrations and Technical Data to the Architect for review prior to procurement. Items of Standard Manufacture shall be submitted, including items purchased to be built into fabricated equipment. Each illustration

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shall be marked to describe accurately the item to be furnished as specified, including voltage, phase, load, accessories, etc.

- C. **Manufacturers' List:** Submit in writing a list of all manufacturers' representatives of the foodservice equipment, such as convection ovens, ranges, etc., and their authorized service agencies' addresses and telephone numbers.
- D. **Foundation Data:** Data and drawings shall be submitted for each item, if any, requiring special foundations, structures, or supports. Such foundations, structures, or supports will be provided and installed by other appropriate trades in accordance with the drawings and specifications which shall be provided by the Contractor and reviewed by the Architect.
- E. **Operation and Maintenance Manuals:** Provide three bound copies of operation, maintenance, and parts manuals for all equipment items of standard manufacture including standard component assemblies built into all custom-fabricated items.
- F. **Review by the Architect of the drawings and brochures submitted by the Contractor does not waive the responsibility of the Contractor to furnish each item of equipment in complete compliance with the specifications and contract drawings.**
- G. **The number of copies of all submittals shall be as determined by the Architect.**
- H. **Samples:** Samples of materials, products, and fabrication methods shall be submitted for review at no additional cost, before proceeding with the work.

1.3 QUALITY ASSURANCE

- A. **Standard Products:** Materials, products, and equipment furnished under this contract shall be the standard items of manufacturers regularly engaged in the production of such materials, products, and equipment and shall be of the manufacturers' latest design that complies with the specifications.
- B. **Manufacturers' Qualifications:** Manufacturers shall be regularly engaged in the production of the items furnished and shall have demonstrated the capability to furnish similar equipment that performs the functions specified or indicated herein.
- C. **Installation Qualifications:** Contractor shall use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work defined in this Section.
- D. **Coordination of Work:** Coordinate work with the respective trades performing preparatory work for installation of equipment under this Contract, including, but not limited to: construction of pits, trenches, receptors; rough-in of supply, waste and vent piping; electrical connections; and field verification of dimensions.
- E. **Product Options:** Drawings indicate foodservice equipment based upon equipment specified herein. All substitutions shall be in compliance with the requirements in Division 1 (or Section I if appropriate.).
- F. **Conflict:** Where written specifications and drawings conflict or appear to conflict, request clarification. Prior to receiving clarification use the greater quality or greater quantity.

1.4 DELIVERY, STORAGE, AND HANDLING

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- A. Deliver foodservice equipment in containers designed to protect equipment and finish until final installation. Make arrangements to receive equipment at project site at a time and place agreed with the General Contractor. If the site is not ready for delivery, then either delay delivery or arrange to hold in a secure and protected warehouse until delivery can be made to job site.
- B. Store foodservice equipment in original containers and in location to provide adequate protection to equipment while not interfering with other construction operations. Coordinate with other trades so that worktables, serving counters and equipment are not used for scaffolding or as workbenches.
- C. Handle foodservice equipment carefully to avoid damage to components, enclosures, and finish. Do not install damaged foodservice equipment; replace and return damaged components to equipment manufacturer.

1.5 APPLICABLE CODES AND STANDARDS

- A. Except as otherwise indicated, each item of equipment shall comply with the latest current edition of the following standards as applicable to the manufacture, fabrication, and installation of the work in this section. Comply with all Federal, State, and Municipal regulations and notifications which bear on the execution of this work. Call to the attention of the Owner in writing any design conflict with the requirements of the Americans with Disabilities Act (ADA) during Bid Process so resolution can be effected prior to Contract Award.
 - 1. NSF Standards: Comply with applicable National Sanitation Foundation standards and criteria and provide NSF "Seal of Approval" on each manufactured item and on major items of custom-fabricated work.
 - 2. UL / ETL / CSA Standards: For electrical components and assemblies, provide either UL / ETL / CSA listed products or, where no listing service is available, provide a complete index of the components used as selected from the UL / ETL / CSA "Recognized Component Index." For fire extinguishing systems comply with UL 300.
 - 3. ANSI Standards: Comply with applicable ANSI standards for electric-powered and gas-burning equipment; for piping to compressed-gas cylinders; and for plumbing fittings, including vacuum breakers and air gaps, to prevent siphonage in water piping.
 - 4. AGA / CGA: All gas-fired equipment shall be AGA / CGA approved, equipped to operate on the type gas available at the job site, and shall contain 100% automatic safety shut-off devices.
 - 5. NFPA Standards: Comply with NFPA Bulletin 96 for exhaust systems; with NFPA Bulletins 13, 17, 17A and 96 for fire extinguishing systems; and with NFPA 54, National Fuel Gas Code and NFPA 70, National Electrical Code.
 - 6. ASME Code: Comply with ASME boiler code requirements for steam-generating and steam-heated equipment; provide ASME inspection, stamps, and certification of registration with National Board.
 - 7. SMACNA Guidelines: Provide seismic restraints for food service equipment to comply with the Sheet Metal and Air Conditioning Contractors National Association's (SMACNA) "Kitchen Equipment Fabrication Guidelines", appendix 1, "Guidelines for Seismic Restraints of Kitchen Equipment", unless otherwise indicated.
 - 8. ASHRAE: Provide mechanical refrigeration systems complying with the American Society of Heating, Refrigerating and Air Conditioning Engineers' ASHRAE 15, "Safety Code for Mechanical Refrigeration".

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- A. Visit the job site to field check actual wall dimensions and roughing-in and be responsible for furnishing, fabricating, and installing the equipment in accordance with the available space and utility services as they exist on the job site for an accurate fit.
- B. Check all door openings, passageways, elevators, etc., to be sure that the equipment can be conveyed to its proper location within the building and, if necessary, check with the Contractor regarding the possibility of holding wall erection, placement of doorjambs, windows, etc., for the purpose of moving the equipment to its proper location. Any removal and rebuilding of walls, partitions, doorjambs, etc., necessary to place the equipment or, if caused by incorrect information on the Contractor's drawings, shall be done at the expense of the Contractor.
- C. Physically check the location and utility size of all "rough-ins" at the job site for compatibility with the equipment being installed before finished floors, walls, and/or ceilings are in place.
- D. Check electrical characteristics and water, steam, and gas pressure. Provide pressure-regulating valves where required for proper operation of equipment.

1.7 GUARANTIES AND WARRANTIES

- A. Self-contained or remote refrigeration systems furnished under this Contract shall be provided with start-up and a one-year service contract providing free service, 24 hours per day, seven days per week, including parts and labor. Hermetic or semi-hermetic compressors shall be covered by the manufacturers' factory warranty for an additional four years. Other equipment provided shall include a one-year warranty covering parts and labor, plus any extended warranties as normally provided by individual manufacturers. Equipment including refrigeration systems both self-contained and remote shall be warranted by the Contractor on the project for one year as indicated in the preceding sentence. The first day of the first year commences upon the issuance of a certificate of occupancy for each area.

PART 2 - PRODUCTS**2.1 GENERAL**

- A. The equipment and its component parts shall be new and unused. All items of standard manufactured equipment shall be current models at the time of delivery. Parts subject to wear, breakage, or distortion shall be accessible for adjustment, replacement, and repair.
- B. Means shall be provided to ensure adequate lubrication for moving parts. Oil holes, grease fittings, and filler caps shall be accessible without the use of tools.
- C. The design of the equipment shall be such as to provide for safe and convenient operation. Covers or other safety devices shall be provided for all items of equipment presenting safety hazards. Such guards or safety devices shall not present substantial interference to the operation of the equipment. Guards shall provide easy access to guarded parts.
- D. Trim shall not be an acceptable substitute for accuracy and neatness. When trim is required and accepted by Architect in lieu of rejection of items of equipment, it shall be the Contractor's responsibility to provide same at no additional cost.

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- E. Unless otherwise specified herein, no material lighter than #20 gauge shall be incorporated into the work. Gauges for sheet iron and sheet steel shall be U.S. Standard Gauges and finished equipment gauge thickness shall not vary more than 5% plus or minus from the thickness indicated below.

<u>GAUGE</u>	<u>THICKNESS</u>	<u>GAUGE</u>	<u>THICKNESS</u>
#10	0.1406" (3.0mm)	#16	0.0625" (1.6mm)
#12	0.1094" (2.5mm)	#18	0.0500" (1.25mm)
#14	0.0781" (2.0mm)	#20	0.0375" (1.0mm)

- F. Materials or work described in words which have a well-known and accepted technical or trade meaning shall be held to refer to such accepted meanings.

2.2 MATERIALS

- A. Submit a certified copy of the mill analysis of materials if requested by the Architect.
- B. Stainless steel sheets shall conform to American Society for Testing and Materials (ASTM) specification A240, Type 304 Condition A, 18-8, having a No. 4 finish. A No. 2B finish shall be acceptable on surfaces of equipment not exposed to view. Sheets shall be uniform throughout in color, finish, and appearance.
- C. Stainless steel tubing and pipe shall be Type 304, 18-8, having a No. 4 finish, and shall conform to either ASTM A213 if seamless or ASTM A249 if welded.
- D. Rolled shapes shall be of the cold-rolled type conforming to ASTM A36.
- E. Galvanized sheet steel shall conform to ASTM A526; where extensive forming to take place, conform to ASTM A527; conform to ASTM A525, coating designation G115, chemical treatment.
- F. Galvanized steel sheets shall be cold-rolled, stretcher leveled, bonderized, and rerolled to ensure a smooth surface.
- G. Castings shall be corrosion-resisting metal containing not less than 30% nickel. Castings shall be rough ground, polished, and buffed to bright luster and free from pit marks, runs, checks, burrs, and other imperfections. In lieu of corrosion-resisting metal castings, die-stamped or cast 18-8 stainless steel will be acceptable.
- H. Millwork materials shall be free from defects impairing strength, durability, or appearance; straight and free from warpage; and of the best grade for their particular function. Wood shall be well seasoned and kiln dried and shall have an average moisture content of 8%, a maximum of 10%, and a minimum of 5%.
1. Plywood and other woodwork of treatable species, where so required by the code, shall be fire-retardant treated to result in a flame spread rating of 25 or less with no evidence of significant progressive combustion when tested for 30 minutes duration under ASTM E84 and shall bear the testing laboratory mark on a surface to be concealed.
 2. Concealed softwood or hardwood lumber shall be of poplar, Douglas fir, basswood, red oak, birch, maple, beech, or other stable wood and shall be select or better grade, unselected for color and grain, surfaced four sides, square-edged, and straight. Basswood may be used where fire-retardant treated materials are required.
 3. Plywood for transparent finish shall conform to U.S. Product Standard PS-51-71, Type I (fully waterproofed bond), with architectural grade face veneers of species as specified, free of all

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pin knots, patches, color streaks and spots, sapwood, and other defects. Plywood designated to have plywood cores shall be of either 5 ply or 7 ply construction. Plywood so designated on the drawings and plywood not otherwise shown shall have a particle board core, cross banding of veneers, and face and back veneers. Particle board cores shall have a 45-pound density, except where the fire retardant treatment requires cores of lesser density.

4. Face veneers shall be matched for color and grain to produce balance and continuity of character. Mineral streaks and other discolorations, worm holes, ruptured grain, loose texture, doze, or shake will not be permitted. Face veneer leaves on each surface shall be full-length, book matched, center matched, and sequence matched. Surfaces shall be sequenced and blueprint matched. Veneers not otherwise indicated shall be plain sliced. Backing veneers for concealed surfaces shall be of a species and thickness to balance the pull of the face veneers.
5. Hardwood plywood for painted surfaces shall conform to U.S. Product Standard PS-51-71, Type I, and shall have sound birch, maple, or other approved close grain hardwood faces suitable for a paint finish.
6. Perforated hardboard shall be a tempered hardboard, 1/4" (6 mm) thick, conforming to Federal Specification LLL-B-810B, Type I, SIS, Finish B (primed), Design B (perforated), with 1/4" (6 mm) diameter holes spaced on 1" (25 mm) centers both ways.
7. Plastic laminate surfaces shall be laminated with thermosetting decorative sheets of the color, pattern, and style as selected by the Architect. Horizontal surfaces shall be laminated with sheets conforming to Federal Specification L-P-508F, Style D, Type I (general purpose), Grade HP, Class 1, 1/16" (2 mm) thick, satin finish, with rough sanded backs. Vertical surfaces shall be laminated with sheets conforming to Federal Specification L-P-598F, Style D, Type II, (vertical surface), Grade HP, Class 1, non-forming, satin finish, 1/32" (1 mm) thick or heavier. Surfacing for curved surfaces shall be laminated from sheets conforming to Federal Specification L-P-508F, Style D, Type III (post-forming), Grade HP, Class 1, satin finish. Balance sheets for backs in concealed locations shall be either reject material of the same type and thickness as the general purpose grade facing or may be .020" (0.5 mm) thick laminate backing sheets conforming to Federal Specification L-P-00508E, Style ND, Type V (backing sheet), Grade HP.
8. Adhesive for application of plastic laminate to wood substrates of counter tops shall be a phenolic, resorcinol, or melamine adhesive conforming to Federal Specification MMM-A-181C and producing a waterproof bond. Adhesive for applying plastic laminate to vertical surfaces shall be either a waterproof type or a water resistant type such as a modified urea-formaldehyde resin liquid glue conforming to Federal Specification MMM-A-188C. Contact adhesive will not be acceptable.
9. Plywood for laminate assemblies shown or specified with plywood core shall be of the 5 or 7 ply construction with sanded close-grain hardwood face and back veneers, laminated with waterproof glue, in thickness shown, conforming to U.S. Product Standard PS-51-71. Particle board for plastic laminate assemblies shown or specified with particle board wood core shall conform to U.S. Products Standard CS-236-66, Type 1 or 2, Grade B (45 pound density), Class 2; except where fire-retardant treatment is required, the density shall conform to the treatment requirements.
- I. Sealant: ASTM C 920; type S, Grade NS, Class 25, use, NT. Provide elastomeric sealant, NSF certified for end use application indicated. Provide sealant that, when cured and washed, meeting requirements of Food and Drug Administration's 21 CFR, Section 177.2600 for use in areas that come in contact with food. Dow-Corning #780 or General Electric "Silastic" or approved equal in

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either clear or approved color to match surrounding surfaces and applied in accordance with sealant manufacturers' recommendations for smooth, sealed finish.

- J. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), Class 1 (clear), Quality q3 (glazing select). Provide products complying with ANSI Z97.1, manufactured by horizontal (roller hearth) process and 1/4" (6 mm) thick, unless otherwise indicated. Provide exposed safety edges, if any, seamed before tempering.
- K. Sound Dampening: NSF-certified, nonabsorbant, hard-drying, sound deadening coating. Provide coating compounded for permanent adhesion to metal in 1/8" (3 mm) thickness that does not chop, flake, or blister.

2.3 FINISHES

- A. Paint and coatings shall be of an NSF approved type suitable for use in conjunction with foodservice equipment. Such paint or coating shall be durable, non-toxic, non-dusting, non-flaking, and mildew resistant; shall comply with all governing regulations; and shall be applied in accordance with the recommendations of the manufacturer.
- B. Exterior, galvanized parts, exposed members of framework, and wrought steel pipe where specified to be painted shall be cleaned, properly primed with rust-inhibiting primer, degreased, and finished with two (2) coats of epoxy-based grey hammertone paint, unless otherwise specified.
- C. Stainless steel, where exposed, shall be polished to a #4 commercial finish. Where unexposed, finish shall be #2B. The grain of polishing shall run in the same direction wherever possible. Where surfaces are disturbed by the fabricating process, such surfaces shall be finished to match adjacent undisturbed surfaces.
- D. Galvanized shelving shall not be painted.
- E. Fabricated equipment shall be spray coated with plastic suitable for protecting the equipment during transport and installation. The coating shall be easily removable and shall be removed after the equipment installation is complete at the work site or, alternatively, when directed by the Architect.
- F. Exposed surfaces on brass, bronze, or steel shall be plated with chromium over nickel in accordance with Federal Specifications WW-P-541, Paragraph 9.5 and Table 9.4, unless otherwise specified.

2.4 ELECTRICAL AND MECHANICAL REQUIREMENTS

- A. Standard UL / ETL / CSA listed materials, devices, and components shall be selected and installed in accordance with NEMA Standards and recommendations and as required for safe and efficient use and operation of the foodservice equipment without objectionable noise, vibration, and sanitation problems.
 - 1. Provide recognized commercial grade signals, "on-off" pushbuttons or switches, and other speed and temperature controls as required for operation of each item, complete with pilot lights and permanent engraved, plastic laminate signs and graphics identifying each item. Provide stainless steel cover plates at controls and signals.
 - 2. Each item requiring electrical power shall be equipped with either a terminal box for permanent connection or with cord and plug for interruptible connection, as indicated. Provide NEMA standard grounding type plugs, where used.

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3. Furnish foodservice equipment completely wired internally using wire and conduit suitable for a wet location, including a separate grounding wire. Provide electrical outlets and receptacles required to be mounted on or in fabricated equipment and interconnect to a suitable terminal box (subpanel, starter, or disconnect switch if so specified) with all wires neatly tagged showing item number, voltage characteristics, and load information.
4. Receptacles for all wall- and floor-mounted outlets will be provided to be used for plug-in equipment with characteristics as noted on the drawings. Provide Hubbell three-wire or four-wire grounding-type connectors and neoprene cords installed on each item of plug-in equipment to match receptacles provided.
5. Electrically heated equipment shall be internally wired to a thermostatic control and an "on-off" red neon light indicator, which shall be mounted in a terminal box on a removable stainless steel access panel.
6. Only rigid steel zinc-coated conduit shall be used, painted to match adjacent surfaces where exposed. Wiring shall be run concealed wherever possible.
7. Provide on, or for, each motor-driven appliance or electrical heating or control unit, a suitable control switch or starter of the proper type and rating.
8. Appliances shall be furnished complete with motors, driving mechanism, starters, and controllers, including but not limited to, master switches, timers, cut-outs, reversing mechanism, and other electrical equipment if and as applicable. Wiring and connection diagrams shall be furnished with electrically operated machines and for electrically wired fabricated equipment.
9. Appliances shall be of rigid construction, free from objectionable vibration. Quietness of operation of all foodservice equipment is a requirement. Remove or repair any equipment producing objectionable noise and/or vibration as directed by the Architect.
10. Motors shall be of the drip-proof, splash-proof, or totally enclosed type, having a continuous duty cycle and ball bearings, except small timing motors which may have sleeve bearings. Motors shall have windings impregnated to resist moisture. Motors located where subject to deposits of dust, lint, or other similar matter from the machine on which installed shall be of the totally enclosed type. Motors shall have ample power to operate the machines for which designated under full load operating conditions without exceeding their nameplate ratings. Horsepower requirements on driven equipment shall be determined by the manufacturer based on normal operation at maximum capacity. The nominal rated motor horsepower shall be not less than the horsepower required for normal operation of the equipment at maximum capacity. Insulation shall be NEMA Class B, or better.
11. Cover plates shall be furnished and installed for all electrical outlets, receptacles, switches, etc., to match the material and finish of the equipment to which they will be fastened.
12. Switches, controls, etc., shall be conspicuously labeled as to use with plastic nameplates secured to the adjacent surface as previously specified in Article 2.01-C. Submit a sample for approval if requested by Architect.
13. Where specified for custom fabricated equipment, provide compartment with electrical sub-panel which shall be pre-wired in conduit concealed in cabinet body construction and connected to all electrical components built into or set upon the counter. Electrical sub-panel shall be UL / ETL / CSA listed, 3-phase, 4-wire circuit breaker type with a ground buss main breaker and individual breakers for each serviced load. Buss shall be copper and the circuit breakers shall be the molded case, bolt-on type with thermomagnetic quick-make, quick-break trip.

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Multi-pole circuit breakers shall have an internal trip bar. The circuit breakers shall have an interrupting capacity of 10,000 amperes at 120 volts sized for 125% of the connected load and a minimum of two (2) extra, single pole, 20 amp circuit breakers shall be provided. The loads shall be connected through the breakers in a phased sequence to balance the load on each phase.

- B. Water inlets shall be located above the positive water level wherever possible to prevent siphoning of liquids into the water supply system. Wherever conditions shall require a submerged inlet, a suitable type of check valve (except in jurisdictions where check valves are prohibited) and vacuum breaker shall be provided with the fixture to prevent siphoning. Where exposed, piping and fittings shall be chrome-plated. Where vacuum breaker piping is through equipment, provide chrome -plated escutcheon plates to cover holes.
1. Provide and install indirect waste lines from equipment which will discharge into floor drains or safe wastes, chrome-plated where exposed. Extend to a point at least 1" (25 mm) (or as required by local or state code) above the rim of the floor drain, cut bottom on 45-degree angle and secure in position.
 2. Horizontal piping lines shall be run at the highest possible elevation and not less than 6" (150 mm) above the floor, through equipment where possible.
 3. No exposed piping in or around fixtures or in other conspicuous places shall show tool marks or more than one thread at the fitting.
 4. Steam operating valves on or in fabricated and purchased foodservice equipment shall be provided with composition hand wheels, which shall remain reasonably cool in service.
 5. Provide suitable gas and liquid pressure-reducing valves for equipment with such components that might reasonably be expected to be affected over a period of time by adverse pressure conditions, including but not limited to dishwashers, booster heaters, coffee urns, ranges, steam boilers, etc.
- C. Provide and install complete refrigeration systems--charged, started, and operating properly--including, but not limited to: compressors, condensers, racks, coils, vibration eliminators, sight glasses (moisture indicating type), expansion valves, filters, oil separators, thermostats, defrost time clocks, all controls and control wiring, liquid line driers, piping, and refrigeration grade copper tubing with all sweat joints using Safety-Silv No. 1200 or approved equal silver solder (with as few joints as possible)
1. Where specifications call for pre-piped lines (i.e., from a fixture to a valve compartment, etc.), provide such work in strict conformance with other sections of the specifications which set forth standards for this type of work or in conformity with the requirements of the ASHRAE Standards or local authorities, whichever is the greater.
 2. Mechanically refrigerated cold pans shall have a normally closed liquid line electric solenoid valve installed before the expansion valve and wired to a silent-type toggle switch complete with an "on-off" red neon light indicator and both mounted in a terminal box on a removable access panel. This switch shall be fed by a separate control circuit and shall not to be wired into the compressor circuit so that it shall stop the flow of refrigerant to the cold pan and not turn off the compressor. The compressor shall then pump down and turn off through the action of the pressure control.

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3. Each refrigeration item specification is written to provide minimum specifications and scope of work. Refrigeration equipment shall be designed and installed to maintain the following general temperatures unless otherwise specified.

a. Walk-In Refrigerators	1.7°C / 35°F
b. Walk-In Freezers	-23.3°C / -10°F
c. Reach-In Refrigerators	1.7°C / 35°F
d. Reach-In Freezers	-23.3°C / -10°F
e. Undercounter Refrigerators	1.7°C / 35°F
f. Undercounter Freezers	-23.3°C / -10°F
g. Cold Pan	-17.8°C / 0°F
h. Work Rooms	10°C / 50°F
4. Provide electrical and refrigeration components needed by the completed system and complete all refrigeration and control connections of and to said components.
5. Provide evaporator coil defrost system on all walk-in refrigerator and freezer rooms where the refrigeration systems are designed to operate at room temperature of less than 35°F (1.7°C).
6. Verify the requirements of and provide any or all additional refrigeration specialty(s) or component(s) required or recommended by the manufacturer for proper operation under the specific operating conditions and location of each system specified.
7. Verify and provide manufacturer's certification (or certification by manufacturer's authorized agent) that the equipment selection hereinafter specified for each refrigeration system is properly sized and shall meet the operating requirements set forth for each system regarding maintaining specified operating temperature, hours of compressor running time, and system pressures and velocities as recommended by the equipment manufacturer(s).
8. During check-out and initial operation, verify that:
 - a. Controls are properly adjusted.
 - b. Condensers are equipped with an overload protector.
 - c. A competent service mechanic is on site during the first eight (8) hours of operation.
 - d. Switches, starters, and controls are identified as to function.
9. Unless otherwise specified, furnish thermometers for walk-in units mounted above the exterior entrance door with suitable length armored capillary tubes to allow the sensing bulbs to be installed in the incoming air stream to the blower coil with runs fastened to the walk-in walls to prevent it from damage. This identical requirement applies to alarm systems when specified.

2.5 PRODUCT SPECIFICATIONS

Refer to Part 4 for complete itemized product specifications.

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PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Begin installing the equipment at the time the building is ready to receive the equipment and in accordance with the schedule.
- B. Provide a competent foreman or supervisor for erection of equipment and to coordinate with other trades regarding connections, installation, and inspection. Coordinate delivery schedule to ensure adequate openings in the building to receive the equipment.
- C. Install refrigeration work in an approved manner, using first quality fittings, controls, valves, etc. Refrigeration items shall be started up, tested, adjusted, and turned over to the Architect in first-class condition and left operating in accordance with the manufacturer's specifications.
- D. Set equipment that rests on masonry bases level onto a bed of silicone rubber sealant.
- E. Seal equipment that butts to a wall or against other equipment with silicone rubber sealant. Set trim strips or other items requiring fasteners in a bed of silicone rubber sealant and fastened with suitable stainless steel fasteners 48" (1200mm) or less on centers. , surfaces shall be thoroughly clean and degrease all surfaces prior to the application of sealant.
- F. Install and interconnect electrical controls, switches, or other units which are separately furnished for field installation in or on equipment provided, unless otherwise specified.
- G. Install and wire refrigeration systems in strict conformance with the manufacturers' instructions and recommendations. Ensure that all refrigeration condensing units are ventilated properly and are accessible for repair, maintenance, and inspection.
- H. Hang evaporator coils per the manufacturer's recommendation at the locations as shown on the drawings. Mount units such that the drain pans are pitched to the drain lines. Hang the coils using nylon or other approved non-conductive, non-corrosive fasteners. Furnish #12 gauge galvanized steel fish plates of suitable size and shape on the exterior ceiling of the walk-in to spread the weight of the coils adequately. Connect coils to the condensing unit and install to constitute a complete working system capable of maintaining the interior temperatures specified regardless of the heavy usage the walk-in units may receive.
- I. Furnish and install a copper or PVC drainline painted silver from each coil outlet to a point 1" (25mm) above the floor drain. Trap drainlines immediately above the floor drain. Provide continuous electrified heater tape for freezer drainlines, coordinate electrical requirements and wiring with electrical division. Insulate drainline after installation.
- J. Refrigeration tubing shall be the Type L, ACR hard drawn degreased, sealed copper and shall be installed with horizontal runs sloped 1" per 20 feet (1:240) toward the condensing units. Refrigerant piping shall be properly supported by adjustable hangers spaced and adjusted to the drop required. Where vertical runs of more than 5' (1500mm) occur in the suction line, trap the risers at the bottom. Install piping so that refrigerant or oil cannot drain back into the coils from the suction line.
- K. Insulate suction and refrigerant lines with minimum 1/2" (13mm) Armstrong armaflex or equal cellular type insulation. Provide metal pipe sleeves where piping passes through a wall, ceiling, or floor. Fill space around the tubing with mastic insulating compound. Install a permanent suction line filter in each compressor suction line with pressure fitting ahead of the filter to facilitate checking of pressure drop through the filter. Fully insulate and seal penetrations through walk-in cooler or freezer structures to be vapor tight to prevent condensation within any light fixtures, switch boxes,

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junction boxes, or any other fittings. Fully seal refrigeration and drain lines and provide escutcheon plates.

- L. Furnish and completely install a thermostat to control the refrigeration temperatures for each individual compartment.
- M. Mount the condensing units on a welded steel rack containing all accessories and components necessary to form a complete condensing unit package. Provide each condensing unit with a factory mounted, pre-wired control panel/disconnect switch complete with circuit breakers, contactors, and time clocks as required.
- N. Furnish the refrigeration systems with a one-year refrigeration service contract, covering all parts and labor, with service available seven days per week, 24-hours per day. Provide an option for continuation of the service contract after the first year.. Warrant the refrigeration system for one year and provide the compressors with the manufacturer's extended five-year warranty.
- O. Furnish four (4) copies of complete remote refrigeration system control wiring and piping diagrams. Frame one (1) copy in Plexiglas and mount at compressor location or inside the refrigeration system enclosure as appropriate.
- P. Coordinate the equipment work with the respective work of other Sections so that electrical and mechanical components built into the equipment will conform and/or adapt to the type, materials, and characteristics of the building components.
- Q. Install heated and motor-driven equipment so as to operate efficiently. Provide additional vents, guards, deflectors, and other accessories as needed at no additional cost. Note such additions or modifications on the shop drawings and bring to Architect's attention by special accompanying letter.

3.2 FABRICATION

- A. Items of fabricated equipment shall be fabricated in the same factory and shall be similar in construction details, materials, methods, and appearance to similar types of items so fabricated under this contract.
- B. Each fabricated item of equipment shall include necessary reinforcing, bracing, and welding with the proper number and spacing of uprights and cross members for strength. Wherever standard sheet sizes will permit, the tops of all tables, shelves, exterior panels of cabinet type fixtures, and doors and drainboards shall be constructed of a single sheet of metal. Except where required to be removable, flat surfaces shall be secured to vertical and horizontal bracing members by welding or other approved means to eliminate buckle, warp, rattle, and wobble. Equipment not braced in a rigid manner and which is subject to rattle and wobble shall be unacceptable, and the Contractor shall add additional bracing in an approved manner to achieve acceptance.
- C. Suitable pipe slots shall be provided on fabricated equipment to accommodate service and utility lines and mechanical connections. These slots shall be of proper size and shall be neatly made with turned up edges around to eliminate cutting or defacing of equipment on the job. Cabinet bases shall be provided with an inner panel duct at the ends or rear of the cabinet allowing adequate space to conceal vertical piping. Such work, when performed at the job site, shall be of the same quality as similar work performed in the shop.
- D. Exposed surfaces shall be free from bolt and screw heads. When bolts are required, they shall be of the concealed type and be of similar composition as the metal to which they are applied. Where bolt or screw threads on the interior of fixtures are visible or may come into contact with hands or wiping cloths, they shall be capped with a stainless steel acorn nut and stainless steel lock washer.

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- E. Where screw threads are not visible or readily accessible, they shall be assembled with stainless steel lock washers and nuts. Wherever bolts or screws are welded to the underside of trim or tops, the reverse side of the weld shall be finished uniformly with the adjoining surfaces. Depressions at these points shall not be acceptable.
- F. Rivets shall not be permitted in any location.
- G. Welding shall be the heliarc method with welding rod of the same composition as the sheets or parts welded. Welds shall be complete, strong, and ductile with excess metal ground off and joints finished smooth to match adjoining surfaces. Welds shall be free of mechanical imperfections such as gas holes, pits, cracks, etc., and shall be continuously welded so that the fixtures shall appear as one piece construction. Butt welds made by spot solder and finished by grinding shall not be acceptable.
 - 1. Spot welds shall have a maximum spacing of 3" (75mm). Tack welds shall be of at least 1/4" (6mm) length of welding material at a maximum space of 4" (100mm) from center to center. Weld spacing at the ends of the channel battens shall not exceed 2" (50mm) centers.
 - 2. In no case shall soldering be accepted.
 - 3. Fixtures shall be shop fabricated of one piece and shipped to the job completely assembled wherever possible. Equipment too large to transport or enter the building as one piece shall be constructed so that the field joints can be welded at the job site.
 - 4. Exposed joints shall be ground flush with adjoining material and finished to harmonize therewith. Whenever material has been depressed by a welding operation, such depression shall be suitably hammered and peened flush with the adjoining surface and, if necessary, again ground to eliminate low spots. In all cases, the grain of rough grinding shall be removed by successive fine polishing operations.
 - 5. Unexposed welded joints on undershelves of tables or counters in stainless steel construction shall be suitably coated at the factory with an approved metallic-based paint.
 - 6. After galvanized steel members have been welded, welds and areas where galvanizing has been damaged shall have a zinc dust coating applied in conformance with U.S. Government Military Specification Number MIL-P-26915.
- H. Butt joints and contact joints, wherever they occur, shall be close fitting and shall not require filler. Wherever break bends occur, they shall be free of undue extrudence and shall not be flaky, scaly, or cracked in appearance; where such breaks do mar the uniform surface appearance of the material, such marks shall be removed by suitable grinding, polishing, and finishing. Wherever sheared edges occur, they shall be free of burrs, fins, and irregular projections and be finished to obviate danger of cutting or laceration when the hand is drawn over them. In no case shall overlapping materials be acceptable where miters or bullnosed corners occur.
- I. The grain of polishing shall run in the same direction on horizontal and on vertical surfaces of each item of fabricated equipment except in the case where the finish of the horizontal sections of each shall terminate in a mitered edge. Where sinks and adjacent drainboards are equipped with backsplash, the grain of polishing shall be consistent in direction throughout the length of the backsplash and sink compartment.
- J. Component parts, whether fabricated by the Contractor or purchased for building into the fabricated equipment, shall conform to the following.

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- K. Bolts, screws, nuts, and washers shall be of steel, except where brass or stainless steel is fastened, in which case they shall be of brass or stainless steel, respectively. Where dissimilar metals are fastened, bolts, screws, nuts, and washers shall be of the higher grade metal. The spacing and extent of bolts and screws shall be such as to ensure suitable fastening and prevent buckling of the metals fastened.

3.3 CLEAN-UP

- A. At completion of the installation, clean up, lubricate, and adjust where necessary items of equipment provided and turn them over in first-class condition.
 - 1. Where stainless steel surfaces are disturbed by the installation or fabricating process, such surface shall be finished to match adjoining undisturbed surfaces.
 - 2. At the completion of the installation work, stainless steel shall be gone over with a portable polishing machine and buffed to perfect surfaces. Painted surfaces shall be carefully gone over and retouched as required.

3.4 START-UP AND TESTING AND COMMISSIONING

- A. Startup Services: Engage factory-authorized service representatives to perform startup services and to demonstrate and train Owner's maintenance personnel as specified below.
 - 1. Coordinate food service equipment startup with service-utility testing, balancing, and adjustments. Do not operate steam lines before they have been cleaned and sanitized.
 - 2. Remove protective coverings and clean and sanitize equipment, both inside and out, and relamp equipment with integral lighting. Where applicable, comply with manufacturer's written cleaning instructions.
 - 3. Test each equipment item for proper operation. Repair or replace equipment that is defective in operation, including units that operate below required capacity or that operate with excessive noise or vibration.
 - 4. Test refrigeration equipment's ability to maintain specified operating temperature under heavy-use conditions. Repair or replace equipment that does not maintain specified operating temperature.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 6. Test motors and rotating equipment for proper rotation and lubricate moving parts according to manufacturer's written instructions.
 - 7. Test water, drain, gas, steam, oil, refrigerant, and liquid-carrying components for leaks. Repair or replace leaking components.
 - 8. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance for each food service equipment item.
 - 9. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."

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10. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
11. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

3.5 SEISMIC RESTRAINTS

- A. Install equipment in these contract documents according to the "SMACNA Guidelines for Seismic Restraint of Kitchen Equipment" in any State, province, or jurisdiction that has legislated this requirement as necessary for acceptance. This shall include:
 1. Identifying these items on his submittal drawings, Plans, Elevations, and Sections.
 2. Showing required SMACNA methods of restraint on his submittal drawings.
 3. Referencing the appropriate detail(s).
 4. Obtain regulatory approval for all seismic engineering details.
- B. If no SMACNA detail exists for a particular situation, prepare and obtain approval for a special attachment detail:
 1. Detail must be prepared by an engineer licensed by the State having jurisdiction over the project and accompanied by the supporting calculations used in the design.
 2. Verify that the restraint design is appropriate to the building's structural conditions and the surfaces to which the equipment will be secured.

PART 4 - ITEMIZED PRODUCT SPECIFICATIONS

The design of the project is based on the following specified equipment. Furnish all equipment in compliance with these specifications. Substitutions, deviations, alternates or owner approved equals must be approved prior to submission for review. All costs associated with re-design, re-engineering and changes to the work shall be paid by the equipment supplier.

GC to review shop drawings, take delivery on site, inspect equipment, set up equipment and INSTALL equipment for all items listed below as purchased by RPS.

<u>ITEM #01</u>	<u>PLASTIC SHELVING UNIT</u>
Manufacturer:	Cambro
Model:	CSU

Camshelving® Starter Unit, width and length x 64"H, 4 shelf, includes: solid bottom shelf, four posts, 2 sets of post connectors, traverses & vented shelf plates, speckled gray, NSF

PURCHASED BY RPS

<u>ITEM #02 - 06</u>	<u>SPARE NUMBER</u>
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SECTION 114000**FOODSERVICE EQUIPMENT****April 3, 2017****ITEM #07** **HAND SINK**

Manufacturer: Eagle Group

Model: HSA-10-1FK

Hand Sink, wall mount, 13-1/2" Wide x 9-3/4" front-to-back x 6-3/4" deep bowl, 304 stainless steel construction, splash mounted faucet, single knee pedal, skirt, basket drain, deep-drawn seamless design-positive drain, inverted "V" edge, NSF

Right and Left end splash

Faucet/Drain – shipped loose to plumber to install on site.

Soap & paper towel dispensers provided by Owner to be installed by KEC

PURCHASED BY RPS**ITEM #07.1** **HAND SINK**

Existing relocated

ITEM #08 **PREP REFRIGERATOR**

Manufacturer: Continental

Model: UC27

Under counter Refrigerator, 27" wide, one-section, (1) field rehingable door, stainless steel front, aluminum top sides & interior, 3-5/8" casters, rear-mounted self-contained refrigeration, 1/5 hp

PURCHASED BY RPS**ITEM #09** **SOILED DISHTABLE**

Manufacturer: Eagle Group

Model: SCTL-48-14/3

Soiled Dishtable, straight design, 48"W x 30"D x 43-1/2"H, left to right to left operation, 14/304 stainless steel top, 8"H backsplash, stainless steel hat channels, 20" x 20" x 5" deep pre-rinse sink with basket drain, (1) splash mount faucet hole for pre-rinse, No scrap block, raised rolled edges on front & side, heavy gauge 304 undershelf, stainless steel legs & side bracing, adjustable feet, NSF

Heavy gauge 304 undershelf

All welded construction

No Disposer in Sink**ITEM #10** **WALL SHELF**

Manufacturer: Eagle Group

Model: WS1224-14/3

Wall Shelf, 12" x 24" 14/304 stainless steel, 1-1/2" roll on front, 1-1/2" upturn on rear & ends, stainless steel mounting brackets stud welded to shelf, NSF

PURCHASED BY RPS**ITEM #12** **PRE-RINSE-SPLASH/WALL MOUNT**

Manufacturer: Fisher

Model: 2210-WB

Pre-Rinse Assembly, 8" adjustable centers, wall-mounted mixing valve, with spring action flexible gooseneck, with spray head (1.15 gallons per minute @ 60 PSI), with wall bracket.

Shipped loose to plumber to install on site

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PURCHASED BY RPS**ITEM #13 DISHWASHER, DOOR TYPE-CORNER**

Manufacturer: Hobart

Model: AM15VLT-2

Ventless Door Type Dishwasher, Energy Recovery, tall chamber, hot water sanitize, internal condensing system, 40 racks/hr, corner design, left to right operation, solid-state controls with digital status, booster heater, electric tank heat, auto-fill, stainless steel tank, doors & feet, ENERGY STAR®

Single point electrical connect AM15 kit (field installation required) 3 phase booster

Two extra (2) Combination rack

Two extra (2) 6 pan rack

PURCHASED BY RPS**ITEM #14 CLEAN DISHTABLE**

Manufacturer: Eagle Group

Model: CDTR-48-14/3

Clean Dishtable, straight design, 48"W x 30"D x 43-1/2"H, left to right operation, 14/304 stainless steel top, 8"H backsplash, stainless steel hat channels, raised rolled edges on front & side, stainless steel legs & crossbracing, adjustable metal feet, NSF

Heavy gauge 304 undershelf

All welded construction

PURCHASED BY RPS**ITEM #15 SHELVING, WALL-MOUNTED**

Manufacturer: Eagle Group

Model: WS1236-14/3

Wall Shelf, 12" x 36" 14/304 stainless steel, 1 1/2" roll on front, 1 1/2" upturn on rear & ends, stainless steel mounting brackets stud welded to shelf, NSF

PURCHASED BY RPS**ITEM #16 THREE (3) COMPARTMENT SINK**

Manufacturer: Eagle Group

Model: FN2860-3-24-14/3

Sink, three compartment, stainless steel, with 24" left & right-hand drainboards, 28" front-to-back x 20"W compartment, 14"D, with 10"H splash, stainless steel open frame base, boxed crossrails, 2 set of faucet holes, 14/304 stainless steel, NSF

S/S Bullet feet

All welded construction

PURCHASED BY RPS

SECTION 114000**FOODSERVICE EQUIPMENT****April 3, 2017****ITEM #17** **FAUCET**

Manufacturer: Fisher

Model: 13277

Faucet, wall/backsplash mount, 8" C.C., 14" long swing spout, 1/2" inlets

Shipped loose to plumber to install on site

PURCHASED BY RPS**ITEM #18** **LEVER WASTE**

Manufacturer: Fisher

Model: 22322

DrainKing Waste Valve, flat strainer, overflow body, 14 x 16 tube & elbow, 12 GPM drain rate, cast red brass body

Shipped loose to plumber to install on site

PURCHASED BY RPS**ITEM #33** **MOBILE WORK TABLE**

Manufacturer: Eagle Group

Model: T3060SE

Work Table, 30"W x 60"D x 34"H, 14/304 stainless steel top with square turndown ends, Uni-Lok® gusset system, 18 gauge stainless steel undershelf, (4) 1-5/8" diameter heavy gauge stainless steel legs, NSF

Square edge table, front and/or rear, per table

Drawer Assembly, 20" x 20" x 5", 430 type stainless steel, removable drawer pan, hemmed safety pull handle

All welded construction

Table Casters, 5" diameter, set of (4), (2) swivel & (2) braked, 250 lb weight capacity per caster, poly cart washable with polymer tread

Pot Rack, table mount, 52"W x 20"D, triple-bar design with tubular table supports, constructed of 3/16" x 2" stainless steel flat bar, includes (15) double-pronged pot hooks, for 60"W table, NSF welded to table

PURCHASED BY RPS**ITEM #34** **HEATED CABINET, MOBILE**

Manufacturer: Food Warming Equip

Model: PHTT-12

Clymate IQ™ Heated Cabinet, mobile, insulated, humidified holding system, oversized water reservoir, top mounted circulating heat system with recessed controls, (12) pair universal stainless steel tray slides

4.5" OC, (12) 18x26x4-1/2 in. pans, stainless steel construction, push-pull air distribution system

5" Caster standard: EZ Roll Heavy Duty Poly, (2) rigid, (2) swivel with brakes

PURCHASED BY RPS

SECTION 114000**FOODSERVICE EQUIPMENT****April 3, 2017****ITEM #35 FRONT COUNTER**

Manufacturer: Custom

Model: Stainless steel

Length per plan x 42"D. Top 14 gauge, 304 stainless steel. 16 ga, Type 304. s/s legs with bullet feet. Constructed in accordance with the front end specifications and drawings. Provide cut-outs for drop-in equipment per plan, food shield and POS cords/cables. Provide hat channel support for drop-in equipment. Provide apron on kitchen side and mount controls. **Provide 11" clearance in front of food shield posts.** Coordinate overhead door location so it does not interfere with food shield and drop in equipment.

Front counter depth based on knee wall depth. Verify knee wall prior to fabrication.

See FS101SC for details

ITEM #35.1 FOOD SHIELD

Manufacturer: BSI

Model: DECO-250-N

Length per plan

Overall Height 14"

Through counter mount.

1/2" tempered glass front and top and side panels, 1-" stainless steel square tubing uprights, narrow mounting flange, NSF, ETL-Brushed stainless

Post placement- First set to second set- 50" o.c. Second set to third set- 50" O.C.

Coordinate with counter manufacturer for correct placement of post holes.

It is the responsibility of the KEC to verify all codes (NSF) are met when placing and installing the food shield.

See FS101F for details

ITEM #36 DROP-IN HOT WELLS

Manufacturer: Vollrath

Model: 36404

3-well hot modular drop-in with infinite controls & standard drains, 18/8 stainless steel, drip-free flange, ind drain shutoffs, 6-3/8" deep wells operate moist or dry, dial controls, NEMA 5-20P, OA 41-1/2"x26", cutout 40-3/4"x25-1/4", 7/8" corner radius

Manifold drain lines in field, separate drain shut-off per well

Cord/Plug- no hard wire connection

ITEM #37 DROP-IN HOT/COLD WELLS

Manufacturer: Vollrath

Model: 3667201

Hot/Cold Drop-In Unit, top mount, (2) pan, remote mountable panel with on-off switch, hot/cold toggle with indicator lights for hot or cold, thermostatic temperature rotary knob control in hot mode, preset cold control, automatic manifold drain, 300 series stainless well & flange, galvanized wrapper, 120v, 5-20P, cULus, NSF, NSF7, Made in U.S.A.

Cord/Plug- no hard wire connection

Wells work independent hot/cold

Manifold drain lines in field; separate drain shut offs per well

ITEM #38 MILK COOLER-EXISTING/PROVIDED BY VENDOR

SECTION 114000**FOODSERVICE EQUIPMENT****April 3, 2017****ITEM #39** **POS**

NIKEC - This is not in the kitchen equipment contract and is shown here for informational purposes only.
General Contractor to confirm all required utilities are provided

ITEM #40 **MOBILE WORK TABLE**

Manufacturer: Eagle Group

Model: T2436SE

Work Table, 36"W x 24"D x 34"H, 14/304 stainless steel top with square turndown ends, Uni-Lok® gusset system, 18 gauge stainless steel undershelf, (4) 1-5/8" diameter heavy gauge stainless steel legs, NSF

Square edge table, front and/or rear, per table

All welded construction

Table Casters, 5" diameter, set of (4), (2) swivel & (2) braked, 250 lb weight capacity per caster, poly cart washable with polymer tread

PURCHASED BY RPS**ITEM #41** **REFRIGERATED SELF-SERVE CASE**

Manufacturer: Structural Concepts

Model: CO35R

Oasis® Self-Service Refrigerated Open Air Screen Case, 36-1/4"L, 61-5/8"H, Breeze-E (Type II) with EnergyWise self-contained refrigeration system, (2) non-lit adjustable metal shelves, top light, black interior, (2) full end panels, 4"D removable wall spacer brackets. 10' Power cord, exit at base, standard

Left and Right end panels: Full with mirrored interior, vinyl edging, standard

Base Support: Seismic Levelers

Back Panel: Solid rear swinging doors with lock

Exterior: Stainless steel

Roll-down security cover, locking

Coordinate wall opening to ensure fit. Wall opening should be within 1"-2" of overall size necessary on top and sides. Trim opening in stainless steel.

Provide means to secure unit in place, so as unit cannot be moved. Method must ensure floor under unit can be easily cleaned.

PURCHASED BY RPS**ITEM #42** **WORK TABLE**

Manufacturer: Eagle Group

Model: T1236SE

Work Table, 36"W x 12"D x 25"H, 14/300 series stainless steel top, square edge on front & back, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (4) stainless steel legs & flanged feet, NSF

Flanged Feet

Square edge front and back

All welded construction

PURCHASED BY RPS

SECTION 114000
FOODSERVICE EQUIPMENT
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ITEM #43 **WORK TABLE W/ SINK****Manufacturer:** **Eagle Group****Model:** **T3072STE-BS**

Work Table, open base, 72"W x 30"D, 14/304 stainless steel top with 6" backsplash and sides turned down 90 degrees, square front edge, square turndown ends, heavy gauge stainless steel 1-1/4" O.D. side & rear crossrails, (4) 1-5/8" O.D. legs, 1" adjustable stainless steel bullet feet, Uni-Lok® system, NSF

 Square edge table, front and rear, per table

 Fabricated sink welded in place, 16" x 20" x 14" bowl, **located per plan**

 Stainless steel bullet feet

Drawer Kit, for all stainless steel work tables, 20" x 20" x 5" enclosed drawer assembly

 All welded construction, legs, undershelf & top

 Enclosed end splash **per plan**

ITEM #44 **FLOOR MIXER**

Existing – for informational purposes only.

ITEM #45 **MOP SINK****Manufacturer:** **Eagle Group****Model:** **F1916-VSCS**

Mop Sink Cabinet, 25"W x 22-1/4"D x 84-1/4"H, 300 stainless steel cabinet body with solid back, slanted top, holds (2) mops, 12" center shelf, 20 gauge stainless steel hinged doors with transverse rod handles & keyed locks, 8" deep bowl with 3" radius corners, 2" NPS drain, includes service faucet, spray hose & spray hose bracket, NSF

 Provide stainless steel back panel

 Upgrade to type 300 stainless steel cabinet

END OF SPECIFICATIONS

DIVISION 22 – PLUMBING
SECTION 22 0000
PLUMBING, GENERAL PURPOSE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 1010 (2002) Self-Contained, Mechanically Refrigerated Drinking-Water Coolers

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.3/CSA 4.3 (2011) Gas Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous

ANSI Z21.22/CSA 4.4 (1999; Addenda A 2000, Addenda B 2001; R 2004) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP (2010; Errata 1-3 2011; INT 1-12 2011; Addenda A, B, C, G, H, J, K, O, P, S, Y, Z, BZ, CG, CI and DS 2012; Errata 4-8 2012; INT 13-16 2012; Errata 9-12 2013; INT 17 2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001 (2008) Performance Requirements for Atmospheric Type Vacuum Breakers (ANSI approved 2009)

ASSE 1010 (2004) Performance Requirements for Water Hammer Arresters (ANSI approved 2004)

ASSE 1011 (2004; Errata 2004) Performance Requirements for Hose Connection Vacuum Breakers (ANSI approved 2004)

ASSE 1012 (2009) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent - (ANSI approved 2009)

ASSE 1013 (2011) Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers - (ANSI approved 2010)

ASSE 1018	(2001) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002)
ASSE 1019	(2011) Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type (ANSI Approved 2004)
ASSE 1020	(2004; Errata 2004; Errata 2004) Performance Requirements for Pressure Vacuum Breaker Assembly (ANSI Approved 2004)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2010; Addenda 2011) Hypochlorites
AWWA B301	(2010) Liquid Chlorine
AWWA C606	(2011) Grooved and Shouldered Joints
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2010) Specification for Brazing Procedure and Performance Qualification

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(2012) Standard for Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.14.1	(2003; R 2012) Backwater Valves
ASME A112.19.1/CSA B45.2	(2008; Update 1 2008; Update 2 2011) Enameled Cast Iron and Enameled Steel Plumbing Fixtures
ASME A112.19.2/CSA B45.1	(2008; Update 1 2009; Update 2 2011) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.19.5	(2011) Trim for Water-Closet Bowls, Tanks and Urinals
ASME A112.36.2M	(1991; R 2012) Cleanouts
ASME A112.6.1M	(1997; R 2012) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2001; R 2007) Standard for Floor and Trench Drains
ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)

ASME B16.12	(2009) Cast Iron Threaded Drainage Fittings
ASME B16.15	(2011; INT thru June 2011) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2012) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(2011) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(2011) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.29	(2012) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(2013) Valves - Flanged, Threaded and Welding End
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.50	(2001; R 2008) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A74	(2013) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A888	(2013) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B111/B111M	(2011) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM B152/B152M	(2013) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B306	(2013) Standard Specification for Copper Drainage Tube (DWV)
ASTM B32	(2008) Standard Specification for Solder Metal
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B42	(2010) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	(2009) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B584	(2013) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B75/B75M	(2011) Standard Specification for Seamless Copper Tube
ASTM B813	(2010) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM C1053	(2000; R 2010) Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications
ASTM C564	(2012) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM D1004	(2013) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1248	(2012) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2665	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2822/D2822M	(2005; E 2011; R 2011) Asphalt Roof Cement

ASTM D2855	(1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3139	(1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3311	(2011) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D4101	(2011) Standard Specification for Polypropylene Injection and Extrusion Materials
ASTM D4551	(2012) Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane
ASTM D638	(2010) Standard Test Method for Tensile Properties of Plastics
ASTM E1	(2007) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E96/E96M	(2012) Standard Test Methods for Water Vapor Transmission of Materials
ASTM F1290	(1998a; R 2011) Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F1760	(2001; R 2011) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F891	(2010) Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2009) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2011) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015 (2010) Copper Tube Handbook

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO PS 117 (2005b) Press Type Or Plain End Rub Gasketed W/ Nail CU & CU Alloy Fittings 4 Install On CU Tubing

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 (2009) Accessible and Usable Buildings and Facilities

ILLINOIS DEPARTMENT OF PUBLIC HEALTH (IDPH)

ILPC (2014) Illinois Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1 (2009) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110 (2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

MSS SP-25 (2008) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-58 (2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MSS SP-67 (2011) Butterfly Valves

MSS SP-69 (2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

MSS SP-72 (2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-80 (2013) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85 (2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NACE INTERNATIONAL (NACE)

NACE SP0169 (1992; R 2007) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2011; Errata 2012) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2011) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2012) National Fuel Gas Code
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 372	(2011) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2013) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2012; Errata 1013; Addenda 2013) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA Fire Man	(2010) Firestopping: Plastic Pipe in Fire Resistive Construction
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PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI G 101	(2010) Testing and Rating Procedure for Hydro Mechanical Grease Interceptors with Appendix of Installation and Maintenance
PDI WH 201	(2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2009) Hose Clamp Specifications
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U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SM 9223	(2004) Enzyme Substrate Coliform Test
Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System
PL 93-523	(1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 430	Energy Conservation Program for Consumer Products
21 CFR 175	Indirect Food Additives: Adhesives and Components of Coatings
40 CFR 141.80	National Primary Drinking Water Regulations; Control of Lead and Copper; General Requirements
PL 109-58	Energy Policy Act of 2005 (EPAAct05)

1.2 SUBMITTALS

The following shall be submitted in accordance with Section [013300](#) SUBMITTAL PROCEDURES:

Shop Drawings

Product Data

Fixtures; List of installed fixtures with manufacturer, model, and flow rate.

Service sinks

Drinking-water coolers

Accessories for Equipment FBO

Plumbing System

Diagrams, instructions, and other sheets proposed for posting.

Test Reports

Tests, Flushing and Disinfection

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Operation and Maintenance Data

Plumbing System

Submit in accordance with Section [017823](#) OPERATION AND MAINTENANCE DATA.

1.3 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products, and as listed on applicable schedules. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

A. Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

B. Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

C. Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

D. Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Architect.

1. Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Architect. Replace damaged or defective items.

1.5 PERFORMANCE REQUIREMENTS

A. Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with IDPH 2004 IPC. Energy consuming products and systems shall be in accordance with PL 109-58 and ASHRAE 90.1 – IP.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Architect of any discrepancy before performing any work.

1.8 INSTRUCTION TO OWNER PERSONNEL

- A. When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Owner personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.
- B. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.
- C. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

2 PART 2 PRODUCTS

2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size and shall comply with NSF/ANSI 14, NSF/ANSI 61 and ASTM F2389. Polypropylene piping that will be exposed to UV light shall be provided with a Factory applied UV resistant coating. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61, Annex G or NSF 372. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

B. Pipe Joint Materials

1. Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:
 - a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310
 - b. Coupling for Steel Pipe: AWWA C606.
 - c. Couplings for Grooved Pipe: Ductile Iron ASTM A536 (Grade 65-45-12), Copper ASTM A536.
 - d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
 - e. Brazing Material: Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.
 - f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.
 - g. Solder Material: Solder metal shall conform to ASTM B32.
 - h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.

- i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.
- j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.
- k. Rubber Gaskets for Grooved Pipe: ASTM D2000, maximum temperature 230 degrees F.
- l. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.
- m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A183.
- n. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D3138.
- o. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855.
- p. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A105/A105M. Blind flange material shall conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A193/A193M.
- q. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D3122.
- r. Press fittings for Copper Pipe and Tube: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for copper press fittings shall be EPDM, FKM or HNBR. Sealing elements shall be factory installed or an alternative supplied fitting manufacturer. Sealing element shall be selected based on manufacturer's approved application guidelines. One complete set of tools for connection repair shall be furnished to the owner.
- s. Copper tubing shall conform to ASTM B88, Type K, L or M.

D. Miscellaneous Materials

- 1. Miscellaneous materials shall conform to the following:
 - a. Water Hammer Arrestor: PDI WH 201. Water hammer arrester shall be diaphragm type.
 - b. Asphalt Roof Cement: ASTM D2822/D2822M.
 - c. Hose Clamps: SAE J1508.
 - d. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.
 - e. Metallic Cleanouts: ASME A112.36.2M.
 - f. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.
 - g. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

- h. Hypochlorites: AWWA B300.
- i. Liquid Chlorine: AWWA B301.
- j. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.
- k. Thermometers: ASTM E1. Mercury shall not be used in thermometers.

E. Pipe Insulation Material

Insulation shall be as specified in Section 22 07 19 PLUMBING PIPING INSULATION.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810: Requirements for Potable-Water Heaters Bottom Drain Valve
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

A. Backwater Valves

Backwater valves shall be either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Valves shall have cast-iron bodies with cleanouts large enough to permit removal of interior parts. Valves shall be of the flap type, hinged or pivoted, with revolving disks. Hinge pivots, disks, and seats shall be nonferrous metal. Disks shall be slightly open in a no-flow no-backwater condition. Cleanouts shall extend to finished floor and be fitted with threaded countersunk plugs.

B. Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22/CSA 4.4. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

C. Thermostatic Mixing Valves

Provide thermostatic mixing valve for lavatory faucets and hand sinks. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

2.4 FIXTURES

Fixtures shall be water conservation type. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature.

A. Drinking-Water Coolers

AHRI 1010 with more than a single thickness of metal between the potable water and the refrigerant in the heat exchanger, wall-hung, bubbler style, air-cooled condensing unit, 4.75 gph minimum capacity, stainless steel splash receptor and basin, and stainless steel cabinet. Bubblers shall be controlled by push levers or push bars, front mounted or side mounted near the

front edge of the cabinet. Bubbler spouts shall be mounted at maximum of 36 inches above floor and at front of unit basin. Spouts shall direct water flow at least 4 inches above unit basin and trajectory parallel or nearly parallel to the front of unit. Provide ASME A112.6.1M concealed steel pipe chair carriers.

D. Fixtures Furnished by Others (FBO)

Provide all required mounting accessories, piping accessories, sanitary, vent and water piping for each fixture for a complete installation. Provide P-trap and drain piping to vertical vent piping from each fixture. Provide angle valve, flexible rise, wheel handle stop, and chrome plated escutcheon. Provide pipe guard where required.

E. Floor Sinks

Floor sinks shall be square] with 12 inch nominal overall width or diameter and 10 inch nominal overall depth. Floor sink shall have an acid-resistant enamel interior finish with cast-iron body, aluminum sediment bucket, and perforated grate of stainless steel. The outlet pipe size shall be as indicated or of the same size as the connecting pipe.

2.5 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees F. Each booster water heater shall have controls with an adjustable range that includes 120 to 180 degrees F. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200 degrees F water temperature and 150 psi working pressure. The expansion tank size and acceptance volume shall be as indicated.

A. Automatic Storage Type

Heaters shall be complete with control system, temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

B. Electric Type

Electric type water heaters shall conform to UL 174 with dual heating elements. Heater shall be rated at 15 KW, 208V, 3 Phase. The elements shall be wired so that only one element can operate at a time. Electric heating elements shall be low watt density with incoloy sheath and 1" screw-in type. Each element shall be controlled by an individually mounted thermostat and high temperature cut-off switch. All internal circuits shall be fused. The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panel and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing. Heater tank shall have a three year limited warranty.

2.6 DRAINS

A. Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 6 inch nominal overall width or diameter and 5 inch nominal overall depth. Drains shall be cast iron with manufacturer's standard

coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.6.3. Install drains flush with floor.

2.7 TRAPS

Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall include a gasketed cleanout. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.8 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Division 26. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Division 26.

2.9 MISCELLANEOUS PIPING ITEMS

A. Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

B. Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where [supply] drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

1. Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2. Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

C. Pipe Hangers (Supports)

Provide MSS SP-58 and MSS SP-69, Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

D. Nameplates

Provide 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 0.25 inch high normal block lettering into the white core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

E. Labels

1. Provide labels for sensor operators at flush valves and faucets. Include the following information on each label:
 - a. Identification of the sensor and its operation with written description.
 - b. Range of the sensor.
 - c. Battery replacement schedule.

3 PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Valves shall be installed with control no lower than the valve body.

A. Water Pipe, Fittings, and Connections

1. Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

2. Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3. Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

4. Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

5. Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

6. Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Architect.

7. Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger shall be provided with thrust blocks,

where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

8. Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted where flush valve outlets are used.

F. Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

1. Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

2. Mechanical Couplings

- a. Mechanical couplings may be used in conjunction with grooved pipe for aboveground, ferrous or non-ferrous, domestic hot and cold water systems, in lieu of unions, brazed, soldered, welded, flanged, or threaded joints.
- b. Mechanical couplings are permitted in accessible locations including behind access plates. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to ensure positive rigid clamping of the pipe.
- c. Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications will not be permitted.
- d. Rigid grooved pipe couplings shall be for use with grooved end pipes, fittings, valves and strainers. Rigid couplings shall be designed for not less than 125 psi service and appropriate for static head plus the pumping head, and shall provide a watertight joint.
- e. Grooved fittings and couplings, and grooving tools shall be provided from the same manufacturer. Segmentally welded elbows shall not be used. Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving

shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations.

- f. The Architect shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and to verify the groove dimensions in accordance with the coupling manufacturer's specifications.
3. Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

4. Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

5. Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

6. Copper Tube and Pipe

- a. Brazed. Brazed joints shall be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.
- b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015.
- c. Copper Tube Extracted Joint. Mechanically extracted joints shall be made in accordance with ICC IPC.
- d. Press connection. Copper press connections shall be made in **strict** accordance with the manufacturer's installation instructions for manufactured rated size. The joints shall be pressed using the tool(s) approved by the manufacturer **of that joint**. Minimum distance between fittings shall be in accordance with the manufacturer's requirements.

7. Plastic Pipe

PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

G. Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

H. Corrosion Protection for Buried Pipe and Fittings

Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Additionally, ductile iron, cast iron, and steel pressure pipe shall have a cathodic protection system and joint bonding. Coatings shall be selected, applied, and inspected in accordance with NACE SP0169 and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

I. Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

1. Sleeve Requirements

- a. Unless indicated otherwise, provide pipe sleeves meeting the following requirements:
- b. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.
- c. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.
- d. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.

- e. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.
- f. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.
- g. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete/masonry wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section FIRESTOPPING.

2. Flashing Requirements

Pipes passing through roof shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3. Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

4. Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 6 inches in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

5. Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant.

6. Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

J. Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section FIRESTOPPING.

K. Supports

1. General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

2. Pipe Hangers, Inserts, and Support

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
 - (1) Be used on insulated pipe less than 4 inches.
 - (2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.
 - (3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:
 - (1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
 - (2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
 - (3) On pipe 4 inches and larger carrying medium less than 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
- m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped

securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

- n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3. Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Architect. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

L. Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

M. Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed

with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

A. Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

N. Height of Fixture Rims Above Floor

Hand Sinks and Lavatories shall be mounted with rim 30 inches above finished floor unless specified otherwise on architectural drawings. Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor, or as shown on architectural drawings. Installation of fixtures for use by the physically handicapped shall be in accordance with ICC A117.1.

O. Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

1. Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

2. Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

3. Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

4. Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

5. Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

P. Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

Q. Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

R. Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors.

3.5 IDENTIFICATION SYSTEMS

A. Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

S. Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are

not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated below:

Color	System	Location
Red	Hot Water	At all Directions Changes and Valve Locations
Blue	Cold Water	At all Directions Changes and Valve Locations

T. Pipe Labels

1. Provide color code marking of piping conforming to ASME A13.1. All piping shall be marked with the type and directional flow arrow. Pipe labels should be positioned so that they can be easily seen from the normal angle of approach—for instance, below the centerline of the pipe if the pipe is overhead, and above the centerline if the pipe is below eye level. Pipe labels shall be placed:
 - a. Adjacent to all valves and flanges
 - b. Adjacent to all changes of direction
 - c. On both sides of wall or floor penetrations
 - d. At regular intervals on straight runs (20' is the acceptable maximum spacing, but closer spacing might be necessary for visibility.)
 - e.

3.6 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.7 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Division 9.

A. Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

1. Factory Painting Systems

- a. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.
- b. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

2. Shop Painting Systems for Metal Surfaces

- a. Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.
- b. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

3. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

4. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

5. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

3.8 TESTS, FLUSHING AND DISINFECTION

A. Plumbing System

The following tests shall be performed on the new portions of plumbing system in accordance with the ILPC, except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure to the Architect for approval.

1. Drainage and Vent Systems Test. The final test shall include a smoke test.
2. Building Sewers Tests.
3. Water Supply Systems Tests.

U. Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

V. System Flushing

1. During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Architect (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

2. After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Comply with ASHRAE 90.1 - IP for minimum efficiency requirements. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 141.80 (c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

W. Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

1. Time, date, and duration of test.
2. Water pressures at the most remote and the highest fixtures.
3. Operation of each fixture and fixture trim.
4. Operation of each valve, hydrant, and faucet.

5. Temperature of each domestic hot-water supply.
6. Operation of each floor and roof drain by flooding with water.
7. Operation of each vacuum breaker and backflow preventer.

X. Disinfection

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

8. Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

9. After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

10. Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

11. Take addition samples of water in disinfected containers, for bacterial examination, at locations specified by the Architect

12. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with EPA SM 9223 and AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

13. Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.9 WASTE MANAGEMENT

Place materials defined as hazardous or toxic waste in designated containers. Return solvent and oil soaked rags for contaminant recovery and laundering or for proper disposal. Close and seal tightly partly used sealant and adhesive containers and store in protected, well-ventilated, fire-safe area at moderate temperature. Place used sealant and adhesive tubes and containers in areas designated for hazardous waste. Separate copper and ferrous pipe waste in accordance with the Waste Management Plan and place in designated areas for reuse.

3.10 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.11 TABLES

TABLE I						
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, AND VENT PIPING SYSTEMS						
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X	X
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888. Pipe and fittings shall be marked with the CISPI trademark.		X	X	X	X
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X	
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A536 And ASTM A47/A47M	X	X		X	X
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A536 and ASTM A47/A47M for use with Item 5	X	X		X	X

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B584, for use with Item 5	X	X		X	X
8	Wrought copper grooved joint pressure pressure fittings for non-ferrous pipe ASTM B75/B75M C12200, ASTM B152/B152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X			
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X
10	Steel pipe, seamless galvanized, ASTM A53/A53M, Type S, Grade B	X			X	X
11	Seamless red brass pipe, ASTM B43				X	X
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X
14	Seamless copper pipe, ASTM B42					
15	Cast bronze threaded fittings, ASME B16.15				X	X
16	Copper drainage tube, (DWV), ASTM B306	X*	X	X*	X	X
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X
18	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D2665, ASTM F891, (Sch 40) ASTM F1760	X		X		

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E
19	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A518/A518M		X			X
SERVICE: A - Underground Building Soil, Waste and Storm Drain B - Aboveground Soil, Waste, Drain in Buildings C - Underground Vent D - Aboveground Vent E - Interior Rainwater Conductors Aboveground * - Hard Temper						

TABLE II				
PIPE AND FITTING MATERIALS FOR DOMESTIC WATER PIPING SYSTEMS				
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C
1	Bronzed flanged fittings, ASME B16.24 for use with Item 14	X	X	
2	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14	X	X	
3	Seamless copper pipe, ASTM B42	X**	X**	X*
4	Cast bronze threaded fittings, ASME B16.15	X	X	
SERVICE: A - Cold Water Service Aboveground B - Hot and Cold Water Distribution 180 degrees F Maximum Aboveground C - Cold Water service, Below Grade Indicated types are minimum wall thicknesses. ** - Type L * - Hard Temper				

END SECTION 22 00 00

DIVISION 22 – PLUMBING
SECTION 22 0719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
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ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 240/A 240M	(2009a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 1136	(2008) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 195	(2000) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C 449	(2007) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 533	(2009) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534/C 534M	(2008) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(2008e1) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C 552	(2007) Standard Specification for Cellular Glass Thermal Insulation

ASTM C 553	(2008) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 591	(2008a) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 592	(2008a) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 795	(2008) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 916	(1985; R 2007) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C 920	(2008) Standard Specification for Elastomeric Joint Sealants
ASTM C 921	(2009) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM D 226	(2006) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 579	(2009) Standard Specification for Greige Woven Glass Fabrics
ASTM E 84	(2009c) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96/E 96M	(2005) Standard Test Methods for Water Vapor Transmission of Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IECC	(2012) International Energy Conservation Code
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220	(2008) Standard on Types of Building Construction
NFPA 255	(2005; Errata 2006) Standard Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS 3779	(1990; Rev A; R 1994) Tape Adhesive, Pressure Sensitive Thermal Radiation Resistant, Aluminum Foil/Glass Cloth
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1.2 SYSTEM DESCRIPTION

- A. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories and performing all operations necessary for the installation of all insulation for the plumbing, heating and air conditioning systems, in strict accordance with the insulation section of this specification and applicable drawings and subject to the terms and conditions of the contract. All insulation should be installed by skilled workmen regularly engaged in this type of work. Insulation shall be fiber glass pipe insulation or products of equal performance, subject to approval prior to installation.
- B. Section 23000 AIR SUPPLY, DISTRIBUTION, AND EXHAUST SYSTEMS applies to work specified in this section.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide noncombustible thermal-insulation system materials, as defined by NFPA 220. Adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, with a flame-spread classification (FSC) of 25 or less and a smoke-developed classification (SDC) of 50 or less. Determine these maximum values in accordance with NFPA 255. Provide coatings and sealants that are nonflammable in their wet state.
- B. Adhesives, coatings, and sealants shall have published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

1.4 SUBMITTALS

Submit the following in accordance with Section 013000 SUBMITTAL PROCEDURES:

Shop Drawings

Submit Installation Drawings for pipe insulation in accordance with paragraph entitled, "Installation of Insulation Systems," of this section.

Product Data

Submit manufacturer's catalog data for the following items:

Plumbing Fixtures and appurtenances

Manufacturer's Instructions

Installation manual for Insulation Materials

PART 2 PRODUCTS

Materials shall be compatible and not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Meet ASHRAE 90.1-2013 and IECC-2014 for Energy Efficiency, and ASTM C 795 requirements for materials to be used on stainless steel surfaces. Provide materials that are asbestos free and conform to the following.

Manufacturers: Johns-Mannville Mikro-Lok, Owens-Corning Evolution.

2.1 INSULATION MATERIALS

Insulation conductances shall be maximum values, as tested at any point, not an average. Replace or augment insulation conductance found by test to exceed the specified maximum by an additional thickness to bring it to the required maximum conductance and a complete finishing system.

A. Mineral Fiber Insulation

1. Conform to ASTM C 592 for Mineral Fiber Insulation and be suitable for surface temperatures up to 370 degrees F, and not less than 4-pound per cubic foot density with thermal conductivity not greater than 0.26 Btu per hour per square foot square per degree F at 150 degrees F mean.
2. Mineral fiber pipe wrap insulation having an insulating efficiency not less than that of the specified thickness of fibrous glass pipe insulation may be provided in lieu of fibrous glass pipe insulation for pipe sizes 10 inches and larger.

B. Fiberglass Insulation

1. Conform to ASTM C 547. Ensure the apparent thermal conductivity does not exceed 0.54 Btu-inch per hour per square foot per degree F at 200 degrees F mean.
2. Fiber glass pipe insulation having an insulating efficiency not less than that of the specified thickness of mineral fiber pipe insulation may be provided in lieu of mineral fiber pipe insulation for aboveground piping.

2.2 ADHESIVES

A. Cloth Adhesives

Adhesives for adhering, sizing, and finishing lagging cloth, canvas, and open-weave glass cloth shall be a pigmented polyvinyl acetate emulsion and conform to the requirements of ASTM C 916, Type I.

B. Vapor-Barrier Material Adhesives

Adhesives for attaching laps of vapor-barrier materials and presized glass cloth and for attaching insulation to itself, to metal, and to various other substrates, must be solvent-base, synthetic-rubber type and conform to the requirements of ASTM C 916, Type I, for attaching fibrous-glass insulation to metal surfaces. Solvent shall be nonflammable.

2.3 INSULATING CEMENT

A. General Purpose Insulating Cement

General purpose insulating cement shall be [diatomaceous silica] [mineral fiber] and conform to ASTM C 195. Composite shall be rated for 1800 degrees F service and have a thermal-conductivity maximum of 0.85 watt per meter per degree Kelvin Btu by inch per hour per square foot for each degree F temperature differential at 200 degrees F mean temperature for 1 inch thickness.

B. Finishing Insulating Cement

Finishing insulating cement shall be mineral-fiber, hydraulic-setting type conforming to ASTM C 449.

2.4 CALKING

Calking used with specified insulation materials shall be an elastomeric joint sealant in accordance with ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.5 CORNER ANGLES

Corner angle piping insulation shall be nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be in accordance with ASTM B 209, Alloy 3003.

2.6 COATINGS

A. Outdoor Vapor-Barrier Finishing

Coatings for outdoor vapor-barrier finishing of insulation surfaces such as fittings and elbows shall be a nonasphaltic, hydrocarbon polymer, solvent-base mastic containing a blend of nonflammable solvents. Conform to the requirements of ASTM C 1136 and ASTM C 921 for coatings.

B. Indoor Vapor-Barrier Finishing

Provide pigmented resin and solvent compound coatings for indoor vapor-barrier finishing of insulation surfaces and conform to ASTM C 1136, Type II.

C. Outdoor and Indoor Nonvapor-Barrier Finishing

Provide pigmented polymer-emulsion type recommended by the insulation material manufacturer for outdoor and indoor nonvapor-barrier finish coating of insulation surfaces for the surface to be coated and applied to specified dry-film thickness.

2.7 TAPE

Provide a knitted elastic cloth glass lagging specifically suitable for continuous spiral wrapping of insulated pipe bends and fittings and produce a smooth, tight, wrinkle-free surface. Conform to requirements of SAE AMS 3779, SAE AMS 3779, ASTM D 579, and ASTM C 921 for tape, and weigh not less than 10 ounces per square yard.

2.8 HOT-WATER PIPING

Provide mineral fiber insulation with the manufacturer's vapor barrier or glass cloth jacket, R-4 with a thickness of not less than 1 inch. Insulate aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces.

2.9 COLD-WATER PIPING

Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated. Provide 3/8" inch mineral fiber insulation with the manufacturer's vapor barrier or glass cloth jacket.

2.10 OTHER PIPING

The first 8 feet of piping in systems penetrating the building envelope above ground shall be insulated with 0.5" insulation with a minimum R-4 value.

PART 3 EXECUTION

3.1 INSTALLATION OF INSULATION SYSTEMS

- A. Install smooth and continuous contours on exposed work. Smoothly and securely paste down cemented laps, flaps, bands, and tapes. Apply adhesives on a full-coverage basis.
- B. Apply insulation only to system or component surfaces that have been tested and approved.
- C. Install insulation lengths tightly butted against each other at joints. Where lengths are cut, provide smooth and square and without breakage of end surfaces. Where insulation terminates, neatly taper and effectively seal ends, or finish as specified. Direct longitudinal seams of exposed insulation away from normal view.
- D. Apply materials in conformance with the recommendations of the manufacturer.
- E. Clean surfaces free of oil and grease before insulation adhesives or mastics are applied. Provide solvent cleaning required to bring metal surfaces to such condition.
- F. Installation Drawings for pipe insulation shall be in accordance with the adhesive manufacturer's written instructions for installation.

3.2 SYSTEM TYPES

- A. Mineral Fiber with Vapor-Barrier Jacket
 - 1. Cover piping with mineral-fiber pipe insulation with factory-and field-attached vapor-barrier jacket. Maintain vapor seal. Securely cement jackets, jacket laps, flaps, and bands in place with vapor-barrier adhesive. Provide jacket overlaps not less than 1-1/2 inches and jacketing bands for butt joints 3 inches wide.
 - 2. Cover exposed-to-view fittings and valve bodies with preformed mineral-fiber pipe-fitting insulation of the same thickness as the pipe-barrel insulation. Temporarily secure fitting insulation in place with light cord ties. Apply a 60-mil coating of white indoor vapor-barrier coating and, while still wet, wrap with glass lagging tape with 50 percent overlap, and smoothly blend into the adjacent jacketing. Apply additional coating as needed and rubber-gloved to smooth fillet or contour coating, then allowed to fully cure before the finish coating is applied. On-the-job fabricated insulation for concealed fittings and special configurations, build up from mineral fiber and a special mastic consisting of a mixture of insulating cement and lagging adhesive diluted with 3 parts water. Where standard vapor-barrier jacketing cannot be used, make the surfaces vapor tight by using coating and glass lagging cloth or tape as previously specified.

3. In lieu of materials and methods previously specified, fittings may be wrapped with a twine-secured, mineral-wool blanket to the required thickness and covered with premolded polyvinylchloride jackets. Make seams vapor tight with a double bead of manufacturer's standard vapor-barrier adhesive applied in accordance with the manufacturer's instructions. Hold all jacket ends in place with AISI 300 series corrosion-resistant steel straps, 15 mils thick by 1/2 inch wide.
4. Set pipe insulation into an outdoor vapor-barrier coating for a minimum of 6 inches at maximum 12-foot spacing and the ends of the insulation sealed to the jacketing with the same material to provide an effective vapor-barrier stop.
5. Do not use staples in applying insulation. Install continuous vapor-barrier materials over all surfaces, including areas inside pipe sleeves, hangers, and other concealments.
6. Piping insulation at hangers shall consist of 13-pounds per cubic foot density, fibrous-glass inserts or expanded, rigid, closed-cell, polyvinylchloride. Seal junctions with vapor-barrier jacket where required, glass-cloth mesh tape, and vapor-barrier coating.
7. Expose white-bleached kraft paper side of the jacketing to view.
8. Finish exposed-to-view insulation with not less than a 6-mil dry-film thickness of nonvapor-barrier coating suitable for painting.

3.3 ACCEPTANCE

Final acceptance is contingent upon providing construction (Record Drawings) details to the Owner. Include construction details, by building area, the insulation material type, amount, and installation method.

END SECTION 22 0719

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AIR SUPPLY, DISTRIBUTION, VENTILATION, & EXHAUST SYSTEMS**PART 1 GENERAL****1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S12.51 (2012) Acoustics Determination of Sound Power Levels of Noise Sources using Sound Pressure Precision Method for Reverberation Rooms

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)

ACCA Manual 4 (2001) Installation Techniques for Perimeter Heating and Cooling; 11th Edition

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 201 (2002; R 2011) Fans and Systems

AMCA 210 (2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMCA 220 (2005) Test Methods for Air Curtain Units

AMCA 300 (2008) Reverberant Room Method for Sound Testing of Fans

AMCA 301 (2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 260 I-P (2012) Sound Rating of Ducted Air Moving and Conditioning Equipment

AHRI 350 (2008) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI 440	(2008) Room Fan-Coils and Unit Ventilators
AHRI 880 I-P	(2011) Performance Rating of Air Terminals
AHRI 885	(2008; Addendum 2011) Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets
AHRI DCAACP	(Online) Directory of Certified Applied Air-Conditioning Products
AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; ERTA 2012; S 2013) Load Ratings and Fatigue Life for Ball Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2013; Addenda A 2014; ERTA 2014) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	(2012; Errata 2013; INT 1 2014) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2010; Errata 2011; INT 3 2012; INT 4 2012; INT 5 2013) Ventilation for Acceptable Indoor Air Quality
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct
ASHRAE 70	(2006; R 2011) Method of Testing for Rating the Performance of Air Outlets and Inlets

ASHRAE 84 (2013; Addenda A 2013) Method of Testing Air-to-Air Heat Exchangers

ASHRAE 90.1 - IP (2010; ERTA 2011-2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME A13.1 (2007; R 2013) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A167 (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A53/A53M (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A924/A924M (2014) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM B117 (2011) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM B152/B152M (2013) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar

ASTM B209 (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B766 (1986; R 2008) Standard Specification for Electrodeposited Coatings of Cadmium

ASTM C1071 (2012) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

ASTM C553 (2013) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

ASTM C916 (2014) Standard Specification for Adhesives for Duct Thermal Insulation

ASTM D1654 (2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D1785	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2013) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2855	(1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3359	(2009; E 2010; R 2010) Measuring Adhesion by Tape Test
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E2016	(2011) Standard Specification for Industrial Woven Wire Cloth
ASTM E84	(2014) Standard Test Method for Surface Burning Characteristics of Building Materials

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001	(2009) HEPA and ULPA Filters
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INTERNATIONAL CODE COUNCIL (ICC)

IMC	(2009) International Mechanical Code
IECC	(2009) International Energy Conservation Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2011) Enclosures
NEMA MG 1	(2011; Errata 2012) Motors and Generators
NEMA MG 10	(2013) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code
NFPA 701	(2010) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 96	(2014) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL
ASSOCIATION (SMACNA)

SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition
SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition
SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF ENERGY (DOE)

PL-109-58	(1992; R 2005) Energy Efficient Procurement Requirements
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U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone
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UNDERWRITERS LABORATORIES (UL)

UL 181	(2013) Factory-Made Air Ducts and Air Connectors
UL 1995	(2011) Heating and Cooling Equipment
UL 555	(2006; Reprint May 2014) Standard for Fire Dampers
UL 586	(2009; Reprint Sep 2014) Standard for High-Efficiency Particulate, Air Filter Units
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel

UL 705	(2004; Reprint Dec 2013) Standard for Power Ventilators
UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL 900	(2004; Reprint Feb 2012) Standard for Air Filter Units
UL 94	(2013; Reprint Sep 2014) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL Bld Mat Dir	(2012) Building Materials Directory
UL Electrical Constructn	(2012) Electrical Construction Equipment Directory
UL Fire Resistance	(2012) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

Furnish all equipment, ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

A. Mechanical Equipment Identification

The number of charts and diagrams shall be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1. Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

2. Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. Provide neat mechanical drawings, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation,

and procedures for safely starting and stopping the system. After approval, post these items where directed.

B. Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Labels shall be in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Rooftop Unit	RTU - [_____]
Cabinet Unit Heater	CUH - [_____]

1. Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:
 - a. Each point of entry and exit of pipe passing through walls.
 - b. Each change in direction, i.e., elbows, tees.
 - c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.
 - d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 50 feet. All labels shall be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes for Outside Diameters of	Lettering
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

C. Color Coding

Color coding of all piping systems shall be in accordance with ASME A13.1.

1.3 SUBMITTALS

Submit the following in accordance with Section [01 30 00](#) SUBMITTALS:

Product Data
Diffusers, Registers and Grilles
Rooftop Units
Cabinet Unit Heaters

Valves
Piping
Duct
Diagrams
Controls

Test Reports
Performance Tests
Damper Acceptance Test
Air Balancing Test

Manufacturer's Instructions
Manufacturer's Installation Instructions
Operation and Maintenance Training

Operation and Maintenance Data
Operation and Maintenance Manuals
Manual Balancing Dampers

1.4 QUALITY ASSURANCE

- A. Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.
1. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.
 2. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.
 3. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

B. Prevention of Corrosion

Protect metallic materials against corrosion. Manufacturer shall provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be

hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations and cadmium-plated in conformance with ASTM B 766 for interior locations.

C. Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

D. As-Built Drawings

Submit detail drawings showing final equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

E. Test Procedures

Submit proposed test procedures and test schedules for the performance tests of systems, at least 2 weeks prior to the start of related testing.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Identification plates shall be three layers, black-white-black, engraved to show white letters on black background. Letters shall be upper case. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high shall be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger shall have beveled edges. Install identification plates using a compatible adhesive.

2.2 ELECTRICAL WORK

- A. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Division

26 ELECTRICAL. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

- B. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1.

2.3 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.4 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing.

2.5 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.6 DUCT SYSTEMS

A. Metal Ductwork

1. Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification.
 - a. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.
 - b. Provide sealants that conform to fire hazard classification specified in Section [23.0700 THERMAL INSULATION FOR MECHANICAL SYSTEMS](#) and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant.
 - c. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer

is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

4. Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is not to exceed 2 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section [23 07 00](#) THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

5. General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

6. Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

7. Corrosion Resisting (Stainless) Steel Sheets

ASTM A167

8. Duct Liner

Provide duct liner at return drops of rooftop units.

B. Diffusers, Registers, and Grilles

Provide factory-fabricated units of steel or aluminum that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and

outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A. Titus, Price, and Carnes are acceptable manufacturers.

1. Supply Ceiling Diffusers

- a. Supply diffusers shall be square, model TMS as manufactured by Titus. Diffusers shall be of the sizes and mounting types shown on the plans. Diffusers shall be selected to integrate with the ceiling system as shown on the architectural plans and as scheduled.
- b. Shall have three cones, which give a uniform face size and appearance when different neck sizes are used in the same area. All cones shall be one piece precision die-stamped; the back cone shall also include an integrally drawn inlet (welded-in inlets and corner joints are not acceptable). The two inner cones shall be constructed as a single, removable inner cone assembly for easy installation and cleaning. The inner cone assembly must have a hole with removable plug in the center to allow quick adjustment of an inlet damper without removing the inner cone assembly. Diffusers shall be constructed of 24-gauge steel.
- c. The finish shall be white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
- d. Round damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the diffuser.
- e. The manufacturer shall provide published performance data for the square diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70.

9. Registers and Grilles

- a. Steel supply grilles shall be Titus Model 300RS (double deflection) of the sizes and mounting types shown on the plans. Registers to match ceiling system type as shown on architectural plans. The deflection blades shall be available parallel to the short dimension of the grille. Construction shall be of steel with a 1¼-inch wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.
- b. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be spaced on ¾-inch centers. Blades shall have steel friction pivots on both ends to allow individual

blade adjustment without loosening or rattling. Plastic blade pivots are not acceptable.

- c. Opposed-blade volume damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the grille.
- d. Steel return grilles shall be Titus Model 350R ($\frac{3}{4}$ -inch blade spacing) of the sizes and mounting types shown on the plans. The fixed deflection blades shall be available parallel to the long dimension of the grille. Construction shall be of steel with a $1\frac{1}{4}$ -inch wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.
- e. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at 35°.
- f. Optional opposed-blade volume damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the grille.
- g. The grille finish shall be white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
- h. The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70.

10. Linear Slot Diffusers

- a. Linear slot diffusers shall be Carnes or Titus (supply) with 1-inch slot spacing of the sizes and mounting types shown on the plans. Linear slot diffusers shall be one 2 foot piece length with 4 discharge slots. Provide air plenum with each unit.
- b. All alignment components to be provided by the manufacturer.
- c. The frame and support bars shall be constructed of heavy gauge extruded aluminum. The pattern controller shall be an aerodynamically curved "ice-tong" shaped steel deflector capable of 180° pattern adjustment from the face of the diffuser and shall allow dampering if required. Maximum pattern controller length shall be 3 feet, for diffusers longer than 3 feet pattern controllers shall be furnished in multiple sections.
- d. The finish shall be white on the face and black on the pattern controllers. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint

must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

- e. Heavy gauge extruded aluminum end borders, end caps and mitered corners shall be available to close off the ends of the diffusers. Plenums shall be manufactured by the same manufacturer of the linear slot diffusers.
- f. The manufacturer shall provide published performance data for the linear slot diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70.

2.7 ROOFTOP UNITS

Acceptable manufacturers shall be Carrier and Aaon.

A. HVAC Equipment Insulation

1. Evaporator fan compartment:

- a. Interior cabinet surfaces shall be insulated with a minimum 1/2-in. thick, minimum 1 1/2 lb density, flexible fiberglass insulation bonded with a phenolic binder, neoprene coated on the air side.
- b. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

B. Gas heat compartment:

- 1. Aluminum foil-faced fiberglass insulation shall be used.
- 2. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

C. Direct-digital Control system for HVAC

1. RTU Open protocol, direct digital controller:

- a. Shall be ASHRAE 62-2001 compliant.
- b. Shall accept 18-30VAC, 50-60Hz, and consumer 15VA or less power.
- c. Shall have an operating temperature range from -40°F (-40°C) to 130°F (54°C), 10% - 90% RH (non-condensing).
- d. Shall include built-in protocol for BACNET (MS/TP and PTP modes), Modbus (RTU and ASCII), Johnson N2 and LonWorks. LonWorks Echelon processor required for all Lon applications shall be contained in separate communication board.

- e. Shall allow access of up to 62 network variables (SNVT). Shall be compatible with all open controllers
- f. Baud rate Controller shall be selectable using a dipswitch.
- g. Shall have an LED display independently showing the status of serial communication, running, errors, power, all digital outputs, and all analog inputs.
- h. Shall accept the following inputs: space temperature, setpoint adjustment, outdoor air temperature, indoor air quality, outdoor air quality, compressor lock-out, fire shutdown, enthalpy switch, and fan status/filter status/ humidity/ remote occupancy.
- i. Shall provide the following outputs: economizer, fan, cooling stage 1, cooling stage 2, heat stage 1, heat stage 2, heat stage 3/ exhaust/ reversing valve.
- j. Shall have built-in surge protection circuitry through solid state polyswitches. Polyswitches shall be used on incoming power and network connections. Polyswitches will return to normal when the "trip" condition clears.
- k. Shall have a battery back-up capable of a minimum of 10,000 hours of data and time clock retention during power outages.
- l. Shall have built-in support for Carrier technician tool.
- m. Shall include an EIA-485 protocol communication port, an access port for connection of either a computer or a Carrier technician tool, an EIA-485 port for network communication to intelligent space sensors and displays, and a port to connect an optional LonWorks communications card.
- n. Software upgrades will be accomplished by either local or remote download. No software upgrades through chip replacements are allowed.

D. Electric and Electronic Control System for HVAC

1. General:

- a. Shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-v transformer side. Transformer shall have 75VA capability.
- b. Shall utilize color-coded wiring.
- c. Shall include a central control terminal board to conveniently and safely provide connection points for vital control functions such as: smoke detectors, phase monitor, gas controller, economizer, thermostat, DDC control options, and low and high pressure switches.
- d. The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor. See heat exchanger section of this specification.

- e. Unit shall include a minimum of one 8-pin screw terminal connection board for connection of control wiring.
- 2. Safeties:
 - a. Compressor over-temperature, over-current. High internal pressure differential.
 - b. Low-pressure switch.
 - 1. Units shall have different sized connectors for the circuit 1 and circuit 2 low and high pressure switches. They shall physically prevent the cross-wiring of the safety switches between circuits 1 and 2.
 - 2. Low pressure switch shall use different color wire than the high pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.
 - c. High-pressure switch.
 - 1. Units shall have different sized connectors for the circuit 1 and circuit 2 low and high pressure switches. They shall physically prevent the cross-wiring of the safety switches between circuits 1 and 2.
 - 2. High pressure switch shall use different color wire than the low pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.
 - d. Automatic reset, motor thermal overload protector.
 - e. Heating section shall be provided with the following minimum protections:
 - 1. High-temperature limit switches.
 - 2. Induced draft motor speed sensor.
 - 3. Flame rollout switch.
 - 4. Flame proving controls.

E. Panel Air Filters

- 1. Standard filter section
 - a. Shall consist of factory-installed, low velocity, disposable 2-in. thick fiberglass filters of commercially available sizes.
 - b. Unit shall use only one filter size. Multiple sizes are not acceptable.
 - c. Filters shall be accessible through a dedicated, weather tight access panel.

- d. 4-in filter capabilities shall be capable with pre-engineered and approved Carrier filter track field installed accessory. This kit requires field furnished filters.

F. Self-Contained Air Conditioners

1. General

- a. Outdoor, rooftop mounted, electrically controlled, heating and cooling unit utilizing a fully hermetic scroll compressor(s) for cooling duty and gas combustion for heating duty.
- b. Factory assembled, single-piece heating and cooling rooftop unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and special features required prior to field start-up.
- c. Unit shall use environmentally sound, Puron refrigerant.
- d. Unit shall be installed in accordance with the manufacturer's instructions.
- e. Unit must be selected and installed in compliance with local, state, and federal codes.

2. Quality Assurance

- a. Unit meets ASHRAE 90.1 minimum efficiency requirements.
- b. Units are Energy Star certified where sizes are required.
- c. Unit shall be rated in accordance with AHRI Standard 340/360.
- d. Unit shall be designed to conform to ASHRAE 15.
- e. Unit shall be ETL-tested and certified in accordance with ANSI Z21.47 Standards and ETL-listed and certified under Canadian standards as a total package for safety requirements.
- f. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
- g. Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).
- h. Unit casing shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 5000-hour salt spray.
- i. Unit shall be designed and manufactured in accordance with ISO 9001.
- j. Roof curb shall be designed to conform to NRCA Standards.

- k. Unit shall be subjected to a completely automated run test on the assembly line. The data for each unit will be stored at the factory, and must be available upon request.
 - l. Unit shall be designed in accordance with UL Standard 1995, ETL listed including tested to withstand rain.
 - m. Unit shall be constructed to prevent intrusion of snow and tested to prevent snow intrusion into the control box up to 40 mph.
 - n. Unit shall be tested to assurance level 1, ASTM D4169 to ensure shipping reliability.
 - o. High Efficient Motors listed shall meet section 313 of the Energy Independence and Security Act of 2007 (EISA 2007).
3. Delivery, Storage, and Handling
- a. Unit shall be stored and handled per manufacturer's recommendations.
 - b. Lifted by crane requires either shipping top panel or spreader bars.
 - c. Unit shall only be stored or positioned in the upright position.
4. Project Conditions
- a. As specified in the contract.
5. Operating Characteristics
- a. Unit shall be capable of starting and running at 125°F (52°C) ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 340/360 at $\pm 10\%$ voltage.
 - b. Compressor with standard controls shall be capable of operation down to 35°F (2°C), ambient outdoor temperatures. Accessory winter start kit is necessary if mechanically cooling at ambient temperatures below 35°F (2°C).
 - c. Unit shall discharge supply air vertically or horizontally as shown on contract drawings.
 - d. Unit shall be factory configured and ordered for vertical supply & return configurations.
 - e. Unit shall be factory furnished for either vertical or horizontal configuration without the use of special conversion kits. No field conversion is possible.
6. Electrical Requirements
- a. Main power supply voltage, phase, and frequency must match those required by the manufacturer.

7. Unit Cabinet

- a. Unit cabinet shall be constructed of galvanized steel, and shall be bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.
- b. Unit cabinet exterior paint shall be: film thickness, (dry) 0.003 inches minimum, gloss (per ASTM D523, 60°F / 16°C): 60, Hardness: H-2H Pencil hardness.
- c. Evaporator fan compartment interior cabinet insulation shall conform to AHRI Standard 340/360 minimum exterior sweat criteria. Interior surfaces shall be insulated with a minimum 1/2-in. thick, 1 lb density, flexible fiberglass insulation, neoprene coated on the air side. Aluminum foil-faced fiberglass insulation shall be used in the gas heat compartment.
- d. Base of unit shall have a minimum of four locations for thru-the-base gas and electrical connections standard. Both gas and electric connections shall be internal to the cabinet to protect from environmental issues.
- e. Base Rail
 - 1. Unit shall have base rails on a minimum of 2 sides.
 - 2. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
 - 3. Holes shall be provided in the base rail for moving the rooftop by fork truck.
 - 4. Base rail shall be a minimum of 16 gauge thickness.
- f. Condensate pan and connections:
 - 1. Shall be a sloped condensate drain pan made of a non-corrosive material.
 - 2. Shall comply with ASHRAE Standard 62.
 - 3. Shall use a 3/4-in -14 NPT drain connection, through the side of the drain pan. Connection shall be made per manufacturer's recommendations.
- g. Top panel:
 - 1. Shall be a multi-piece top panel linked with water tight flanges and locking systems.
- h. Gas Connections:
 - 1. All gas piping connecting to unit gas valve shall enter the unit cabinet at a single location on side of unit (horizontal plane).
 - 2. Thru-the-base capability
 - a. Standard unit shall have a thru-the-base gas-line location using a raised, embossed portion of the unit basepan.

b. Thru-the-base provisions/connections are available as standard with every unit. When bottom connections are required, field furnished couplings are required.

c. No basepan penetration, other than those authorized by the manufacturer, is permitted.

i. Electrical Connections

1. All unit power wiring shall enter unit cabinet at a single, factory-prepared, knockout location.

2. Thru-the-base capability.

a. Thru-the-base provisions/connections are available as standard with every unit. When bottom connections are required, field furnished couplings are required.

b. No basepan penetration, other than those authorized by the manufacturer, is permitted.

j. Component access panels (standard)

1. Cabinet panels shall be easily removable for servicing.

2. Unit shall have one factory installed, tool-less, removable, filter access panel.

3. Panels covering control box and filter shall have molded composite handles while the blower access door shall have an integrated flange for easy removal.

4. Handles shall be UV modified, composite. They shall be permanently attached, and recessed into the panel.

5. Screws on the vertical portion of all removable access panel shall engage into heat resistant, molded composite collars.

6. Collars shall be removable and easily replaceable using manufacturer recommended parts.

G. Gas Heat

1. General

- a. Heat exchanger shall be an induced draft design. Positive pressure heat exchanger designs shall not be allowed.
- b. Shall incorporate a direct-spark ignition system and redundant main gas valve.
- c. Gas supply pressure at the inlet to the rooftop unit gas valve must match that required by the manufacturer.
- d. The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor.
- e. IGC board shall notify users of fault using an LED (light-emitting diode).
- f. The LED shall be visible without removing the control box access panel.
- g. IGC board shall contain algorithms that modify evaporator-fan operation to prevent future cycling on high temperature limit switch.
- h. Unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch or 4 continuous short cycles on the high temperature limit switch. Fault indication shall be made using an LED.

2. Standard Heat Exchanger construction

- a. Heat exchanger shall be of the tubular-section type constructed of a minimum of 20-gauge steel coated with a nominal 1.2 mil aluminum-silicone alloy for corrosion resistance.
- b. Burners shall be of the in-shot type constructed of aluminum-coated steel.
- c. Burners shall incorporate orifices for rated heat output up to 2000 ft (610m) elevation. Additional accessory kits may be required for applications above 2000 ft (610m) elevation, depending on local gas supply conditions.
- d. Each heat exchanger tube shall contain multiple dimples for increased heating effectiveness.

3. Optional Stainless Steel Heat Exchanger construction

- a. Use energy saving, direct-spark ignition system.
- b. Use a redundant main gas valve.
- c. Burners shall be of the in-shot type constructed of aluminum-coated steel.
- d. All gas piping shall enter the unit cabinet at a single location on side of unit (horizontal plane).

- e. 5. The optional stainless steel heat exchanger shall be of the tubular-section type, constructed of a minimum of 20-gauge type 409 stainless steel.
 - f. Type 409 stainless steel shall be used in heat exchanger tubes and vestibule plate.
 - g. Complete stainless steel heat exchanger allows for greater application flexibility.
4. Induced draft combustion motor and blower
- a. Shall be a direct-drive, single inlet, forward-curved centrifugal type.
 - b. Shall be made from steel with a corrosion-resistant finish.
 - c. Shall have permanently lubricated sealed bearings.
 - d. Shall have inherent thermal overload protection.
 - e. Shall have an automatic reset feature.

H. Coils

1. Standard Aluminum Fin/Copper Tube Coils:

- a. Standard evaporator and condenser coils shall have aluminum lanced plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.
- b. Evaporator coils shall be leak tested to 150 psig, pressure tested to 450 psig, and qualified to UL 1995 burst test at 1775 psig.
- c. Condenser coils shall be leak tested to 150 psig, pressure tested to 650 psig, and qualified to UL 1995 burst test at 1980 psig.

I. Refrigerant Components

1. Refrigerant circuit shall include the following control, safety, and maintenance features:

- a. Thermostatic Expansion Valve (TXV) shall help provide optimum performance across the entire operating range. Shall contain removable power element to allow change out of power element and bulb without removing the valve body.
- b. Refrigerant filter drier - Solid core design.
- c. Service gauge connections on suction and discharge lines.
- d. Pressure gauge access through a specially designed access screen on the side of the unit.

2. Compressors

- a. Unit shall use fully hermetic, scroll compressor for each independent refrigeration circuit.
- b. Models shall be available with 2 compressor/2-stage cooling.
- c. Compressor motors shall be cooled by refrigerant gas passing through motor windings.
- d. Compressors shall be internally protected from high discharge temperature conditions.
- e. Compressors shall be protected from an over-temperature and over-amperage conditions by an internal, motor overload device.
- f. Compressor shall be factory mounted on rubber grommets.
- g. Compressor motors shall have internal line break thermal, current overload and high pressure differential protection.
- h. Crankcase heaters shall not be required for normal operating range, unless provided by the factory.

J. Filter Section

1. Filters access is specified in the unit cabinet section of this specification.
2. Filters shall be held in place by a preformed, slide-out filter tray, facilitating easy removal and installation.
3. Shall consist of factory-installed, low velocity, throw-away 2-in. thick fiberglass filters.
4. Filters shall be standard, commercially available sizes.
5. Only one size filter per unit is allowed.
6. 4-in filter capability is possible with a field installed pre engineered slide out filter track accessory. 4-in filters are field furnished.

K. Evaporator Fan and Motor

1. Evaporator fan motor:
 - a. Shall have inherent automatic-reset thermal overload protection or circuit breaker.
 - b. Shall have a maximum continuous bhp rating for continuous duty operation; no safety factors above that rating shall be required.
2. Belt-driven Evaporator Fan:

- a. Belt drive shall include an adjustable-pitch motor pulley and belt break protection system.
- b. Shall use rigid pillow block bearing system with lubricant fittings at accessible bearing or lubrication line.
- c. Blower fan shall be double-inlet type with forward-curved blades.
- d. Shall be constructed from steel with a corrosion resistant finish and dynamically balanced.
- e. Standard on all 17-28 size Humidi-MiZer models.

L. Condenser Fans and Motors

1. Condenser fan motors:

- a. Shall be a totally enclosed motor.
- b. Shall use permanently lubricated bearings.
- c. Shall have inherent thermal overload protection with an automatic reset feature.
- d. Shall use a shaft-down design.

2. Condenser Fans:

- a. Shall be a direct-driven propeller type fan.
- b. Shall have galvalum blades riveted to corrosion-resistant steel spiders and shall be dynamically balanced.

M. Special Features Options and Accessories

1. Standard Integrated Economizers:

- c. Integrated, gear-driven opposing blade design type capable of simultaneous economizer and compressor operation.
- d. Independent modules for vertical or horizontal return configurations shall be available. Vertical and horizontal return modules shall be available as a factory installed option.
- e. Damper blades shall be galvanized steel with composite gears. Plastic or composite blades on intake or return shall not be acceptable.
- f. Shall include all hardware and controls to provide free cooling with outdoor air when temperature and/or humidity are below setpoints.

- g. Shall be equipped with gear driven dampers for both the outdoor ventilation air and the return air for positive air stream control.
- h. Standard models shall be equipped with low-leakage dampers, not to exceed 2% leakage at 1 in. wg pressure differential. Economizer controller on electromechanical units shall be Honeywell W7212 that provides:
 - 1) Combined minimum and DCV maximum damper position potentiometers with compressor staging relay.
 - 2) Functions with solid state analog enthalpy or dry bulb changeover control sensing.
 - 3) Contain LED indicates for:
 - I) When free cooling is available
 - II) When module is in DCV mode
 - III) When exhaust fan contact is closed
- i. Ultra low leak EconoMi\$er X system shall be available on models with SAV 2-speed Variable Frequency Drive (VFD) systems. Only available on 2-speed indoor fan motor systems with electromechanical, ComfortLink or RTU Open controls.
 - 1) Maximum damper leakage rate to be equal to or less than 4.0 cfm/sq. ft. at 1.0 in. w.g., meeting or exceeding ASHRAE 90.1 requirements. Economizer controller on electromechanical units shall be Honeywell W7220 that provides:
 - 2) 2-line LCD interface screen for setup, configuration and troubleshooting.
 - 3) On-board fault detection and diagnostics
 - 4) Sensor failure loss of communication identification
 - 5) Automatic sensor detection
 - 6) Capabilities for use with multiple-speed indoor fan systems
 - 7) Utilize digital sensors: Dry bulb and Enthalpy
- j. Shall be capable of introducing up to 100% outdoor air.
- k. Shall be equipped with a barometric relief damper capable of relieving up to 100% return air.
- l. Shall be designed to close damper(s) during loss-of-power situations with spring return built into motor.
- m. Dry bulb outdoor air temperature sensor shall be provided as standard. Outdoor air sensor setpoint shall be adjustable and shall range from 40 to 100°F / 4 to 38°C. Additional sensor options shall be available as accessories.
- n. The economizer controller shall also provide control of an accessory power exhaust unit function. Factory set at 100%, with a range of 0% to 100%.
- o. The economizer shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy. A remote potentiometer may be used to override the damper setpoint.
- p. Dampers shall be completely closed when the unit is in the unoccupied mode.

- q. Economizer controller shall accept a 2-10 Vdc CO2 sensor input for IAQ/DCV control. In this mode, dampers shall modulate the outdoor air damper to provide ventilation based on the sensor input.
 - r. Compressor lockout sensor shall open at 35°F (2°C) and close closes at 50°F (10°C).
 - s. Actuator shall be direct coupled to economizer gear. No linkage arms or control rods shall be acceptable.
 - t. Economizer controller shall provide indications when in free cooling mode, in the DCV mode, or the exhaust fan contact is closed.
2. Humidi-MiZer Adaptive Dehumidification System (3 Phase Models Only).
- a. The Humidi-MiZer Adaptive Dehumidification System shall be factory installed and shall provide greater dehumidification of the occupied space by two modes of dehumidification operations in addition to its normal design cooling mode:
 - 1) Subcooling mode further sub cools the hot liquid refrigerant leaving the condenser coil when both temperature and humidity in the space are not satisfied.
 - 2) Hot gas reheat mode shall mix a portion of the hot gas from the discharge of the compressor with the hot liquid refrigerant leaving the condenser coil to create a two-phase heat transfer in the system, resulting in a neutral leaving air temperature when only humidity in the space is not satisfied.
 - 3) Includes head pressure controller.

3. Head Pressure Control Package (MotorMaster)
 - a. Controller shall control coil head pressure by condenser-fan speed modulation or condenser-fan cycling and wind baffles.
 - b. Shall consist of solid-state control and condenser-coil temperature sensor to maintain condensing temperature at outdoor ambient temperatures down to -20°F (-29°C).
4. Unit-Mounted, Non-Fused Disconnect Switch:
 - a. Switch shall be factory-installed, internally mounted.
 - b. National Electric Code (NEC) and ETL approved non-fused switch shall provide unit power shutoff.
 - c. Shall be accessible from outside the unit.
 - d. Shall provide local shutdown and lockout capability.
5. Convenience Outlet:
 - a. Powered convenience outlet.
 - 1) Outlet shall be powered from main line power to the rooftop unit.
 - 2) Outlet shall be powered from line side of disconnect by installing contractor, as required by code. If outlet is powered from load side of disconnect, unit electrical ratings shall be ETL certified and rated for additional outlet amperage.
 - 3) Outlet shall be factory-installed and internally mounted with easily accessible 115-v female receptacle.
 - 4) Outlet shall include 15 amp GFI receptacles with independent fuse protection.
 - 5) Voltage required to operate convenience outlet shall be provided by a factory-installed step-down transformer.
 - 6) Outlet shall be accessible from outside the unit.

6. Centrifugal Propeller Power Exhaust:

- a. Power exhaust shall be used in conjunction with an integrated economizer.
- b. Independent modules for vertical or horizontal return configurations shall be available.
- c. Horizontal power exhaust is shall be mounted in return ductwork.
- d. Power exhaust shall be controlled by economizer controller operation. Exhaust fans shall be energized when dampers open past the 0-100% adjustable setpoint on the economizer control.

7. Indoor Air Quality (CO2) Sensor:

- a. Shall be able to provide demand ventilation indoor air quality (IAQ) control.
- b. The IAQ sensor shall be available in duct mount, wall mount, or wall mount with LED display. The setpoint shall have adjustment capability.

2.8 CABINET UNIT HEATERS

Acceptable manufacturers shall be Modine or equal.

A. Performance

- 1. Unit capacities shall be certified under Industry Room Fan-Coil Air Conditioner Certification Program in accordance with AHRI Standard 440-97. All standard units shall be ETL listed in the United States and Canada and comply with NFPA 90A requirements.

B. General Construction

- 1. The units shall include a chassis, coils, fan wheels, fan casings, fan board and motors. Steel parts exposed to moisture shall be galvanized and if necessary, insulated to prevent condensation. The complete fan assembly, which includes the motor shall be easily removed for service and maintenance. A quick-disconnect motor electrical plug shall be provided. The standard chassis construction shall be 18-gauge galvanized steel. Units shall be acoustically and thermally insulated with closed-cell material.

C. Cabinet

1. Floor models shall be provided with stamped louvers and a one inch high dust barrier at the bottom. The cabinet shall be 18-gauge steel with 16 gauge front panels. All painted surfaces shall be treated for corrosion resistance prior to being finished with a tan, baked on polyester powder coat finish. All unpainted steel shall be galvanized.
2. Color as selected by architect shall be provided in one of 8 optional colors as shown on manufacturer's color chart 75-403.
3. Wall or ceiling models shall have cabinets with stamped louvers. The entire bottom of the unit must be enclosed. Access to the speed control shall be through the easy access 16-gauge front panels.
4. An access door shall be provided for speed control access.
5. All models shall have two 9" minimum wide piping end pockets. All wall and ceiling units shall have safety hinged access panels that can be easily removed during installation.

D. Coils

1. The heating coils shall provide specified capacities and not exceed the pressure drop and GPM listed in this catalog. The 1 & 2 row coils shall be suitable for 200 PSI working pressure with 240°F water or 10psi steam. The 3 & 4 row coils shall be suitable for 200 PSI working pressure with 200°F water.

E. Supply Fan

1. Blowers shall be of the centrifugal, forward curved type, to provide even air distribution and low sound level. All units shall have shaded pole (permanent split capacitor available when specified as optional equipment) direct-drive motors. The motor and blower assembly shall be capable of being easily removed from the unit. Motors are built for continuous duty to NEMA standards.

F. Motor

1. The unit shall have a unit-mounted solid state motor speed control, with high through low speeds and off positions on all models. Disconnect Switch.
2. A unit-mounted disconnect switch shall be provided on all units as a standard option.

G. Filter Section

1. All air, both fresh and return, shall be filtered by a cleanable expanded aluminum filter. Controls

H. Valve/Piping Packages

1. All piping packages shall be initially tested at 400 psig (2760 kPa) then re-tested once integrated in the cabinet and soldered to the coil at 300 psig (2,069 kPa) The maximum working pressure of the interconnecting piping shall be 300 psig (2,069 kPa). Hydronic unit heater units shall be provided with factory-installed valve/piping

packages, available for the main heating coil. Left or right hand coil connections shall be available, verify required connection side for each unit prior to ordering. The interconnecting piping shall be 1/2" nominal (5/8" OD) copper pipe.

I. Control valves

1. Two-Way and Three-Way Modulating Control Valves shall be rated for a maximum close off pressure of 50 psig (345 kPa). 2- or 3-way modulating valves shall modulate the water flow through the coil in response to a signal from the thermostat or controller. The 3-wire floating (0-10 Vdc proportional) modulating valves shall be factory-mounted in the supply water pipe upstream of the coil.

2.9 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A 123/A 123M or ASTM A 924/A 924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D 520 Type I.

Factory painting that has been damaged prior to acceptance by the Contractor shall be field painted in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

2.10 SUPPLEMENTAL COMPONENTS/SERVICES

A. Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Division 22 and Section 23 05 15 Common Piping for HVAC except as modified herein.

B. Insulation

The requirements for shop and field applied insulation are specified in Section [23 07 00](#) THERMAL INSULATION FOR MECHANICAL SYSTEMS.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Architect of any discrepancy before performing the work.

3.2 INSTALLATION

- A. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.
- B. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices).
- C. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

D. Condensate Drain Lines

Provide water seals in the condensate drain from all units. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section [23 0700](#) THERMAL INSULATION FOR MECHANICAL SYSTEMS.

E. Equipment and Installation

Provide frames and supports for tanks, compressors, boilers, pumps, valves, air handling units, fans, coils, dampers, VVT boxes, and other similar items requiring supports. Ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer.

F. Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section [05 5013](#) MISCELLANEOUS METAL FABRICATIONS.

G. Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the

duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

H. Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

I. Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84. Provide top and bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA 1966. Provide welded pins, cup-head pins, or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA 1966 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.

J. Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

K. Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section [23 0700](#) THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums up to the point where the outdoor air reaches the conditioning unit or up to the point where the outdoor air mixes with the outside air stream.

L. Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 6-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 14 calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse, protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C 553, Type 1, Class B-2.

- A. Sleeves: Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A 53/A 53M, Schedule 20.
- B. Framed Prepared Openings: Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.
- C. Insulation: Provide duct insulation in accordance with Section [23 07 00](#) THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.
- D. Closure Collars: Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.
- E. Firestopping: Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

- A. Temperatures less than 120 degrees F: Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.
- B. Temperatures between 120 and 400 degrees F: Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

3.8 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.9 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section [23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC](#). Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.10 PERFORMANCE TESTS

- A. After testing, adjusting, and balancing is complete as specified, test each system as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Record the testing during the applicable season. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Conduct capacity tests and general operating tests by an experienced engineer. Provide tests that cover a period of not less than 7 days for each system and demonstrate that the entire system is functioning according to the specifications. Make coincidental chart recordings at points indicated on the drawings for the duration of the time period and record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.
- B.
- C. Submit test reports for the [ductwork leak test, and] performance tests in booklet form, upon completion of testing. Document phases of tests performed including initial test summary, repairs/adjustments made, and final test results in the reports.

3.11 CLEANING AND ADJUSTING

Thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans

that are operated during construction, and install new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust modulating automatic control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.12 OPERATION AND MAINTENANCE

A. Operation and Maintenance Manuals

Submit three manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

B. Operation and Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Architect. Make the training period consist of a total of 16 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

END SECTION 23 00 00

DIVISION 23 – MECHANICAL
SECTION 23 05 15
COMMON PIPING FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325 (2011) Steel Construction Manual

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding

AWS WHB-2.9 (2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASME INTERNATIONAL (ASME)

ASME A112.18.1/CSA B125.1 (2012) Plumbing Supply Fittings

ASME A112.19.2/CSA B45.1 (2013) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals

ASME B1.20.7 (1991; R 2013) Standard for Hose Coupling Screw Threads (Inch)

ASME B16.1 (2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.11 (2011) Forged Fittings, Socket-Welding and Threaded

ASME B16.22 (2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.25 (2012) Standard for Buttwelding Ends

ASME B16.26 (2013) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

ASME B16.3 (2011) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.39 (2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300

ASME B16.4 (2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250

ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.3	(2012) Process Piping
ASME B36.10M	(2004; R 2010) Standard for Welded and Seamless Wrought Steel Pipe
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M	(2013) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2013) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A197/A197M	(2000; R 2011) Standard Specification for Cupola Malleable Iron
ASTM A216/A216M	(2012) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A234/A234M	(2013; E 2014) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A276	(2013a) Standard Specification for Stainless Steel Bars and Shapes
ASTM A278/A278M	(2001; R 2011) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A312/A312M	(2013b) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

ASTM A480/A480M	(2013b) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A6/A6M	(2013a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A74	(2013a) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B32	(2008) Standard Specification for Solder Metal
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B749	(2003; R 2009) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM C109/C109M	(2013) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C404	(2011) Standard Specification for Aggregates for Masonry Grout
ASTM C476	(2010) Standard Specification for Grout for Masonry
ASTM C553	(2013) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C564	(2012) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C67	(2013a) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants

ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2308	(2007; R 2013) Standard Specification for Thermoplastic Polyethylene Jacket for Electrical Wire and Cable
ASTM E1	(2013) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E814	(2013a) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	(2013a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011) Standard Classification System for Nonmetallic Gasket Materials
ASTM F2389	(2010) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

FLUID SEALING ASSOCIATION (FSA)

FSA-0017	(1995e6) Standard for Non-Metallic Expansion Joints and Flexible Pipe Connectors Technical Handbook
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 515	(2011) Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications
IEEE C2	(2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-125	(2010) Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2011) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011; Errata 2012) Motors and Generators
NEMA MG 10	(2001; R 2007) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013) National Electrical Code
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NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2014) Plastics Piping System Components and Related Materials
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UNDERWRITERS LABORATORIES (UL)

UL 1479	(2003; Reprint Oct 2012) Fire Tests of Through-Penetration Firestops
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1.2 GENERAL REQUIREMENTS

- A. Section [23 00 00](#) Air Supply, Distribution, Ventilation, and Exhaust Systems applies to work specified in this section
- B. Section [23 05 48](#) Vibration isolation for HVAC Piping and Equipment applies to work specified in this section.
- C. Section 23 05 29 Hangars and Supports for HVAC Piping and Equipment applies to work specified in this section.
- D. Submit Records of Existing Conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of the existing conditions.

1.3 SUBMITTALS

Submit the following in accordance with Section [01 33 00](#):

Preconstruction Submittals

Material, Equipment, and Fixture Lists

Shop Drawings

Record Drawings

Connection Diagrams

Coordination Drawings

Fabrication Drawings

Installation Drawings

Product Data

Pipe and Fittings

Piping Specialties

Valves

Miscellaneous Materials

Supporting Elements

Equipment Foundation Data

Samples

Manufacturer's Standard Color Charts

Design Data

Pipe and Fittings

Piping Specialties

Valves

Test Reports

Hydrostatic Tests

Air Tests

Valve-Operating Tests

Drainage Tests

Pneumatic Tests

Non-Destructive Electric Tests

System Operation Tests

Certificates

Record of Satisfactory Field Operation

List of Qualified Permanent Service Organizations

Listing of Product Installations

Records of Existing Conditions

Surface Resistance

Shear and Tensile Strengths

Temperature Ratings

Bending Tests

Flattening Tests

Transverse Guided Weld Bend Tests

Operation and Maintenance Data

Operation and Maintenance Manuals

1.4 QUALITY ASSURANCE

E. Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Provide standard products in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

F. Alternative Qualifications

Products having less than a two-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

G. Service Support

Ensure the equipment items are supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. Select service organizations that are reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

H. Manufacturer's Nameplate

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

I. Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret

references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Regional Office of Education.

1. Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions are considered mandatory, the word "should" is interpreted as "shall." Reference to the "code official" is interpreted to mean the "Regional Office of Education." References to the "permit holder" are interpreted to mean the "Contractor."

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Owner. Replace damaged or defective items. NOTE: Use this paragraph for other than SOUTHNAVFACENGCOM projects.

1.6 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Ensure motors, controllers, disconnects and contactors conform to and have electrical connections provided under Section 26 29 13 Enclosed Controllers and 26 28 16 Enclosed Switches and Circuit Breakers. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors is not permitted. Provide controllers and contactors with a maximum of 120 volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of additional electrical service and related work under the section that specified that motor or equipment. Provide power wiring and conduit for field installed equipment under and conform to the requirements Electrical Specifications Division 26.

1.7 ELECTRICAL INSTALLATION REQUIREMENTS

Ensure electrical installations conform to IEEE C2, NFPA 70, and requirements specified herein.

A. New Work

Provide electrical components of mechanical equipment, such as motors, motor, control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not permitted. Provide under Division 26, the interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, [the motor control equipment forming a part of motor control centers,] and the electrical power circuits, except internal wiring for components of package equipment is provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

B. Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

C. High Efficiency Motors

1. High Efficiency Single-Phase Motors

Unless otherwise specified, provide high efficiency single-phase fractional-horsepower alternating-current motors corresponding to the applications listed in NEMA MG 11.

2. High Efficiency Polyphase Motors

Unless otherwise specified, select polyphase motors based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, ensure polyphase squirrel-cage medium induction motors with continuous ratings meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

D. Three-Phase Motor Protection

Provide controllers for motors rated one one horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.8 INSTRUCTION TO OWNER PERSONNEL

- J. When specified in other sections, furnish the services of competent instructors to give full instruction to the designated OWNER personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Provide instructors thoroughly familiar with all parts of the installation and trained in operating theory as well as practical operation and maintenance work.
- K. Give instruction during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished is as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.
- L. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

Submit equipment and performance data for pipe and fittings consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

A. Type BCS, Black Carbon Steel

1. Ensure pipe 1/8 through 12 inches is Schedule 40 black carbon steel, conforming to ASTM A53/A53M.
3. Ensure pipe 1/8 through 10 inches is Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M, Grade B Type S (seamless). Grade A should be used for permissible field bending, in both cases.
4. Ensure pipe 12 through 24 inches is 0.375-inch wall seamless black carbon steel, conforming to ASTM A53/A53M, Grade B Type S (seamless).
5. Ensure fittings 2 inches and under are 150-pounds per square inch, gage (psig) working steam pressure (wsp) banded black malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.
6. Ensure unions 2 inches and under are 250 pounds per square inch, wsp female, screwed, black malleable iron with brass-to-iron seat, and ground joint, conforming to ASME B16.39.
7. Ensure fittings 2-1/2 inches and over are Steel butt weld, conforming to ASTM A234/A234M and ASME B16.9 to match pipe wall thickness.
8. Ensure flanges 2-1/2 inches and over are 150-pound forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

B. Type BCS-125, 125-psi Service

1. NOTE: This pipe is applicable for steam- and condensate-piping systems at pressures less than 125 pounds per square inch (psi). Avoid screwed-end connections in condensate piping wherever possible. See Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS for black carbon steel pipe for higher pressure ratings.
2. Ensure pipe 1/8 through 1-1/2 inches is Schedule 40 steam, Schedule 80 condensate, furnace butt weld, black carbon steel, conforming to ASTM A53/A53M, Type F (furnace butt welded, continuous welded) and ASME B36.10M.
3. Ensure pipe 2 through 10 inches is Schedule 40 steam, Schedule 80 condensate, seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M Grade B Type S (seamless) and ASME B36.10M.
4. Ensure pipe 12 through 24 inches is 0.375-inch wall, seamless black carbon steel, conforming to ASTM A53/A53M Type S (seamless) and ASME B36.10M.
5. Ensure fittings 2 inches and under are 125-psig wsp, cast iron, screwed end, conforming to ASTM A126 Class A and ASME B16.4.

6. Ensure fittings 2-1/2 inches and over are wall thickness to match pipe, long radius butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB and ASME B16.9.
7. Conform grooved pipe couplings and fittings in accordance with paragraph entitled, "Grooved Pipe Couplings and Fittings," of this section.

C. Type GCS, Galvanized Carbon Steel

1. Ensure pipe 1/2 through 10 inches, and where indicated is Schedule 40 seamless galvanized steel conforming to ASTM A53/A53M, Grade B Type S (seamless).
2. Ensure pipe 12 inches and over is 0.375-inch wall, seamless, galvanized steel, conforming to ASTM A53/A53M, Grade B.
3. Ensure fittings 2 inches and under are 150-psig wsp banded galvanized malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.
4. Ensure unions 2 inches and under are 150-psig wsp female, screwed, galvanized malleable iron with brass-to-iron seat and ground joint.
5. Ensure fittings 2-1/2 inches and over are 125-psig wsp cast-iron flanges and flanged fittings, conforming to ASTM A126, Class A and ASME B16.1.
6. Conform grooved pipe couplings and fittings in accordance with paragraph entitled, "Grooved Pipe Couplings and Fittings," of this section.
7. As an option, use 150-psig wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A197/A197M and ASME B16.3.

D. Type GCS-DWV, Galvanized Steel Drain, Waste and Vent

1. Ensure pipe (all sizes) is Schedule 40 seamless galvanized carbon steel, conforming to ASTM A53/A53M, Grade A.
2. Furnace butt weld pipe is acceptable for sizes less than 2 inches.
3. Provide risers 3 inches and larger are Type CISP-DWV.
4. Ensure fittings are galvanized, uncoated, screwed, cast iron, recessed pattern drainage fittings, conforming to ASTM A126.
5. Use long radius fittings wherever space permits. Short-turn tees, branches, and ells may be used for vent piping and connections of branch lines to battery fixtures, except wall-hung water closets.

E. Type CISP-DWV, Cast-Iron Drain, Waste and Vent

Provide soil pipe drain, waste, and vent bell-and-spigot type pipe cast iron, conforming to ASTM A74. Caulk and lead all joints in lines where necessary to provide proper leaktight support and alignment; other-wise joints may be two-gasket system type chloroprene, conforming to ASTM C564. Select the extra heavy (CISP-DWV-XH) pipe class.

F. Type CPR, Copper

1. Type CPR-A, Copper Above Ground

2. Ensure tubing 2 inches and under is seamless copper tubing, conforming to ASTM B88, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).
 3. Ensure fittings 2 inches and under are 150-psig wsp wrought-copper solder joint fittings conforming to ASME B16.22.
 4. Ensure unions 2 inches and under are 150-psig wsp wrought-copper solder joint, conforming to ASME B16.22.
 5. Provide brazing rod with Classification BCuP-5, conforming to AWS A5.8/A5.8M.
 6. Or use solder, alloy Sb-5, conforming to ASTM B32.
- M. Type CPR-U, Copper Under Ground
1. Provide Type K seamless copper tube piping, conforming to ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Ensure fittings for connection to corporation cocks are cast bronze, flared-type, conforming to ASME B16.26. Braze the joints.
- N. Type CPR-INS, Copper Under Ground Insulated
1. Provide insulated Type K seamless copper tube piping conforming to ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Braze the joints.
 2. Provide insulation not less than 2 inches thick, suitable for continuous service temperatures of not less than 250 degrees F. Use factory-molded, closed-cell polyurethane foam insulation of not less than 2.5 pounds per cubic foot density. Waterproof insulation with an extruded rigid Type II virgin polyvinylchloride, with minimum wall thickness of 60 mils through 4 inches outside diameter, 85 mils through 6.625 inches and 110 mils through 12.750 inches. Provide fitting covers fabricated from the same materials and thickness as adjacent pipe covering according to the manufacturer's directions.
- O. Grooved Pipe Couplings and Fittings
1. Provide housing for all couplings, fabricated in two or more parts, of black, ungalvanized malleable iron castings. Ensure coupling gasket is molded synthetic rubber, conforming to ASTM D2000. Ensure coupling bolts are oval-neck, track-head type, with hexagonal heavy nuts conforming to ASTM A183.
 2. Fabricate all pipe fittings used with couplings of black, ungalvanized malleable iron castings. Where a manufacturer's standard-size malleable iron fitting pattern is not available, approved fabricated fittings may be used.
 3. Fabricate fittings from Schedule 40 or 0.75-inch wall ASTM A53/A53M, Grade B seamless steel pipe; long radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A234/A234M and ASME B16.9.

2.2 PIPING SPECIALTIES

Submit equipment and performance data for piping specialties consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

A. Dielectric Connections

1. Electrically insulate dissimilar pipe metals from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

B. Expansion Vibration Isolation Joints

1. Construct single or multiple arch-flanged expansion vibration isolation joints of steel-ring reinforced chloroprene-impregnated cloth materials. Design joint to absorb the movement of the pipe sections in which installed with no detrimental effect on the pipe or connected equipment. Back flanges with ferrous-metal backing rings. Provide control rod assemblies to restrict joint movement. Coat all nonmetallic exterior surfaces of the joint with chlorosulphinated polyethylene. Provide grommets in limit bolt hole to absorb noise transmitted through the bolts.
2. Ensure joints are suitable for continuous-duty working temperature of at least 250 degrees F.
3. Fill arches with soft chloroprene.
4. Ensure joint, single-arch, movement limitations and size-related, pressure characteristics conform to FSA-0017.

C. Flexible Pipe

1. Construct flexible pipe vibration and pipe-noise eliminators of wire-reinforced, rubber-impregnated cloth and cord materials and be flanged. Back the flanges with ferrous-metal backing rings. Ensure service pressure-rating is a minimum 1.5 times actual service, with surge pressure at 180 degrees F.
2. Construct flexible pipe vibration and pipe noise eliminators of wire-reinforced chloroprene-impregnated cloth and cord materials. Ensure the pipe is flanged. Provide all flanges backed with ferrous-metal backing rings. Coat nonmetallic exterior surfaces of the flexible pipe with an acid- and oxidation-resistant chlorosulphinated polyethylene. Rate the flexible pipe for continuous duty at 130 psi and 250 degrees F.
3. Ensure unit pipe lengths, face-to-face, are not less than the following:

<u>INSIDE DIAMETER</u>	<u>UNIT PIPE LENGTH</u>
To 3 inches, inclusive	18 inches
4 to 10 inches, inclusive	24 inches
12 inches and larger	36 inches

D. Flexible Metallic Pipe

1. Ensure flexible pipe is the bellows-type with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.
2. Minimum working pressure rating is 100 psi at 300 degrees F.
3. Ensure minimum burst pressure is four times working pressure at 300 degrees F. Bellows material is AISI Type 316L corrosion-resistant steel. Ensure braid is AISI 300 series corrosion-resistant steel wire.

4. Ensure welded end connections are Schedule 80 carbon steel pipe, conforming to ASTM A106/A106M, Grade B.
5. Provide threaded end connections; hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A312/A312M.
6. Ensure flanged end connection rating and materials conform to specifications for system primary-pressure rating.

E. Flexible Metal Steam Hose

1. Provide a bellows type hose with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.
2. Ensure the working steam pressure rating is 125 psi at 500 degrees F.
3. Ensure bellows material is AISI Type 316L corrosion-resistant steel. Braid is AISI Type 300-series corrosion-resistant steel wire.
4. Provide threaded end connections; hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A312/A312M.
5. Ensure flanged end connection rating and materials conform to specifications for system primary-pressure rating.

F. Metallic Expansion Joints

1. Provide Type I expansion joints; Class 2 (double bellows, expansion joint).
2. Design and construct joints to absorb all of the movements of the pipe sections in which installed, with no detrimental effect on pipe or supporting structure.
3. Rate, design, and construct joints for pressures to 125 psig and temperatures to 500 degrees F.
4. Ensure joints have a designed bursting strength in excess of four times their rated pressure.
5. Ensure joints are capable of withstanding a hydrostatic test of 1.5 times their rated pressure while held at their uncompressed length without leakage or distortion that may adversely affect their life cycle.
6. Ensure life expectancy is not less than 10,000 cycles.
7. Ensure movement capability of each joint exceeds calculated movement of piping by 100 percent.
8. Provide bellows and internal sleeve material of AISI Type 304, 304L, or 321 corrosion-resistant steel.
9. End connections require no field preparation other than cleaning.
10. Flanges of flanged-end expansion joints conform to the same codes and standard requirements as are applicable to companion flanges specified for the given piping system at the indicated joint location.
11. Provide joints, 2-1/2 inches and smaller, with internal guides and limit stops.

12. Provide joints, 3 inches and larger, with removable external covers, internal sleeves, and purging connection. Size sleeves to accommodate lateral clearance required, with minimum reduction of flow area, and with oversized bellows where necessary. When a sleeve requires a gasket as part of a locking arrangement, provide the gasket used by the manufacturer. Joints without purging connection may be provided; however, remove these from the line prior to, or not installed until, cleaning operations are complete.
13. Ensure expansion joints have four, equidistant, permanent tram points clearly marked on each joint end. Locate points to prevent obliteration during installation. Include distance between tram points indicating installed lengths in shop drawings.
14. Ensure each expansion joint has adjustable clamps or yokes provided at quarter points, straddling the bellows. Overall joint length is set by the manufacturer to maintain joints in manufacturer's recommended position during installation.
15. Permanently and legibly mark each joint with the manufacturer's name or trademark and serial number; the size, series, or catalog number; bellows material; and directional-flow arrow.

G. Hose Faucets

1. Construct hose faucets with 1/2 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection, conforming to ASME A112.18.1/CSA B125.1. Ensure hose-coupling screw threads conform to ASME B1.20.7.

H. Sleeve Couplings

1. Sleeve couplings for plain-end pipe consist of one steel middle ring, two steel followers, two chloroprene or Buna-N elastomer gaskets, and the necessary steel bolts and nuts.
2. Pump Suction Strainers
3. Provide a cast iron strainer body, rated for not less than 25 psig at 100 degrees F, with flanges conforming to ASME B16.1, Class 125. Strainer construction is such that there is a machined surface joint between body and basket that is normal to the centerline of the basket.
4. Ensure minimum ratio of open area of each basket to pipe area is 3 to 1. Provide a basket with AISI 300 series corrosion-resistant steel wire mesh with perforated backing.
5. Ensure mesh is capable of retaining all particles larger than 1,000 micrometer, with a pressure drop across the strainer body of not more than 0.5 psi when the basket is two-thirds dirty at maximum system flow rate. Provide reducing fittings from strainer-flange size to pipe size.
6. Provide a differential-pressure gage fitted with a two-way brass cock across the strainer.
7. Provide manual air vent cocks in cap of each strainer.

2.3 VALVES

Submit equipment and performance data for valves consisting of corrosion resistance and life expectancy. Submit design analysis and calculations consisting of rates of flow, head losses, inlet and outlet design, and pressure calculations. Also include in data, pipe dimensions, as well as temperature ratings, vibration and thrust limitations, minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

A. Ball and Butterfly Valves

1. Ensure ball valves conform to MSS SP-72 for Figure [1A], 1 piece body [1B], vertically split body [1C], top entry [1D], three piece body and are rated for service at not less than 175 psig at 200 degrees F. For valve bodies in sizes 2 inches and smaller, use screwed-end connection-type constructed of Class A copper alloy. For valve bodies in sizes 2-1/2 inches and larger, use flanged-end connection type. Balls and stems of valves 2 inches and smaller are manufacturer's standard with hard chrome plating finish. Balls and stems of valves 2-1/2 inches and larger are manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves 6 inches and larger may be Class D with 900 Brinell hard chrome plating. Ensure valves are suitable for flow from either direction and seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. Ensure all valves have adjustable packing glands. Seats and seals are fabricated from tetrafluoroethylene.
 2. Ensure butterfly valves conform to MSS SP-67 and are the wafer type for mounting between specified flanges. Ensure valves are rated for 150-psig shutoff and nonshock working pressure. Select bodies of cast ferrous metal conforming to ASTM A126, Class B, and to ASME B16.1 for body wall thickness. Seats and seals are fabricated from resilient elastomer designed for field removal and replacement.
- B. Drain, Vent, and Gage Cocks
1. Provide lever handle drain, vent, and gage cocks, ground key type, with washer and screw, constructed of polished ASTM B62 bronze, and rated 125-psi wsp. Ensure end connections are rated for specified service pressure.
 2. Ensure pump vent cocks, and where spray control is required, are UL umbrella-hood type, constructed of manufacturer's standard polished brass. Ensure cocks are 1/2-inch ips male, end threaded, and rated at not less than 125 psi at 225 degrees F.
- C. Gate Valves (GAV)
1. Ensure gate valves 2 inches and smaller conform to MSS SP-80. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated use union-ring bonnet, screwed-end type. Make packing of non-asbestos type materials. Use rising stem type valves.
 2. Ensure gate valves 2-1/2 inches and larger, are Type I, (solid wedge disc, tapered seats, steam rated); Class 125 (125-psig steam-working pressure at 353 degrees F saturation); and 200-psig, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Select flanged valves, with bronze trim and outside screw and yoke (OS&Y) construction. Make packing of non-asbestos type materials.
- D. Globe and Angle Valves (GLV-ANV)
1. Ensure globe and angle valves 2 inches and smaller, are 125-pound, 125-psi conforming to MSS SP-80 and to requirements specified herein. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated, use union-ring bonnet, screwed-end type. Ensure disc is free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Make packing of non-asbestos type materials. Ensure disk and packing are suitable for pipe service installed.
 2. Ensure globe and angle valves, 2-1/2 inches and larger, are cast iron with bronze trim. Ensure valve bodies are cast iron conforming to ASTM A126, Class A, as specified for Class 1 valves under MSS SP-80. Select flanged valves in conformance with ASME B16.1. Valve construction is outside screw and yoke (OS&Y) type. Make packing of non-asbestos type materials.

E. Standard Check Valves (SCV)

1. Ensure standard check valves in sizes 2 inches and smaller are 125-psi swing check valves except as otherwise specified. Provide lift checks where indicated. Ensure swing-check pins are nonferrous and suitably hard for the service. Select composition type discs. Ensure the swing-check angle of closure is manufacturer's standard unless a specific angle is needed.
2. Use cast iron, bronze trim, swing type check valves in sizes 2-1/2 inches and larger. Ensure valve bodies are cast iron, conforming to ASTM A126, Class A and valve ends are flanged in conformance with ASME B16.1. Swing-check pin is AISI Type or approved equal corrosion-resistant steel. Angle of closure is manufacturer's standard unless a specific angle is needed. Ensure valves have bolted and gasketed covers.
3. Provide check valves with external spring-loaded, positive-closure devices and valve ends are flanged.

F. Nonslam Check Valves (NSV)

1. Provide check valves at pump discharges in sizes 2 inches and larger with nonslam or silent-check operation conforming to MSS SP-125. Select a valve disc or plate that closes before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Ensure valve is Class 125 rated for 200-psi maximum, nonshock pressure at 150 degrees F in sizes to 12 inches. Use valves that fitted with flanges conforming to ASME B16.1. Valve body may be cast iron, or equivalent strength ductile iron. Select disks using manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Ensure pins, springs, and miscellaneous trim are manufacturer's standard corrosion-resistant steel. Disk and shaft seals are Buna-N elastomer tetrafluoroethylene.

2.4 MISCELLANEOUS MATERIALS

Submit equipment and performance data for miscellaneous materials consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

A. Bituminous Coating

1. Ensure the bituminous coating is a solvent cutback, heavy-bodied material to produce not less than a 12-mil dry-film thickness in one coat, and is recommended by the manufacturer to be compatible with factory-applied coating and rubber joints.
2. For previously coal-tar coated and uncoated ferrous surfaces underground, use bituminous coating solvent cutback coal-tar type, conforming to MIL-C-18480.

B. Bolting

1. Ensure flange and general purpose bolting is hex-head and conforms to ASTM A307, Grade B (bolts, for flanged joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts conform to ASTM A563. Square-head bolts and nuts are not acceptable. Ensure threads are coarse-thread series.

C. Elastomer Caulk

2. Use two-component polysulfide- or polyurethane-base elastomer caulking material, conforming to ASTM C920.

D. Escutcheons

1. Manufacture escutcheons from nonferrous metals and chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Ensure metals and finish conforms to ASME A112.19.2/CSA B45.1.
2. Use one-piece escutcheons where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. Ensure all escutcheons have provisions consisting of setscrews for maintaining a fixed position against a surface.

E. Flashing

1. Ensure sheetlead conforms to ASTM B749, UNS Alloy Number L50049 (intended for use in laboratories and shops in general application) OR UNS Alloy Number L51121 (for use where lead sheet of high purity and improved structural strength is indicated).
2. Ensure sheet copper conforms to ASTM B370 and be not less than 16 ounces per square foot weight.

F. Flange Gaskets

1. Provide compressed non-asbestos sheets, conforming to ASTM F104, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 750 degrees F.

G. Grout

1. Provide shrink-resistant grout as a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to ASTM C404 and ASTM C476.
2. Ensure shrink-resistant grout is a combination of pre-measured and packaged epoxy polyamide or amine resins and selected aggregate mortar grouting compound conforming to the following requirements:

Tensile strength		1,900 psi, minimum
Compressive strength	ASTM C109/C109M	14,000 psi, minimum
Shrinkage, linear		0.00012 inch per inch, maximum
Water absorption	ASTM C67	0.1 percent, maximum
Bond strength to		1,000 psi, minimum steel in shear minimum

H. Pipe Thread Compounds

1. Use polytetrafluoroethylene tape not less than 2 to 3 mils thick in potable and process water and in chemical systems for pipe sizes to and including 1-inch ips. Use polytetrafluoroethylene dispersions and other suitable compounds for all other applications upon approval by the Engineer; however, do not use lead-containing compounds in potable water systems.

2.5 SUPPORTING ELEMENTS

- A. Submit equipment and performance data for the supporting elements consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

- B. Provide all necessary piping systems and equipment supporting elements, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. Ensure supporting elements are suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.
- C. Ensure supporting elements conform to requirements of ASME B31.3, and MSS SP-58, except as noted.
- D. Ensure attachments welded to pipe are made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.
- E. Ensure supporting elements exposed to weather are hot-dip galvanized or stainless steel. Select materials of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Electroplate supporting elements in contact with copper tubing with copper.
- F. Provide support elements that are cataloged, load rated, commercially manufactured products per Section 23 05 29 Hangars and Supports for HVAC Piping and Equipment.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

- A. Submit certificates for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Provide certificates verifying Surface Resistance, Shear and Tensile Strengths, Temperature Ratings, Bending Tests, Flattening Tests and Transverse Guided Weld Bend Tests.
- B. Provide test reports for Hydrostatic Tests, Air Tests, Valve-Operating Tests, Drainage Tests, Pneumatic Tests, Non-Destructive Electric Tests and System Operation Tests, in compliance with referenced standards contained within this section.
- C. Fabricate and install piping systems in accordance with ASME B31.3, MSS SP-58, and AWS WHB-2.9.
- D. Submit Installation Drawings for pipes, valves and specialties. Drawings include the manufacturer's design and construction calculations, forces required to obtain rated axial, lateral, or angular movements, installation criteria, anchor and guide requirements for equipment, and equipment room layout and design. Ensure drawings specifically advise on procedures to be followed and provisions required to protect expansion joints during specified hydrostatic testing operations.
- E. Ensure connections between steel piping and copper piping are electrically isolated from each other with dielectric couplings (or unions) rated for the service.
- F. Make final connections to equipment with unions and provided every 100 feet of straight run. Provide unions in the line downstream of screwed- and welded-end valves.
- G. Ream all pipe ends before joint connections are made.
- H. Make screwed joints with specified joint compound with not more than three threads showing after joint is made up.
- I. Apply joint compounds to the male thread only and exercise care to prevent compound from reaching the unthreaded interior of the pipe.
- J. Provide screwed unions, welded unions, or bolted flanges wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

- K. Securely support piping systems with due allowance for thrust forces, thermal expansion and contraction. Do not subject the system to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.
- L. Ensure field welded joints conform to the requirements of the AWS WHB-2.9, ASME B31.3, and ASME BPVC SEC IX.
- M. Make piping systems butt weld joints with backing rings. Use compatible backing ring materials with materials being joined. Ensure joint configuration conforms to ASME B16.25.
- N. Accomplish preheat and postheat treatment of welds in accordance with ASME BPVC SEC IX and ASME B31.3.
- O. Take all necessary precautions during installation of flexible pipe and hose including flushing and purging with water, steam, and compressed air to preclude bellows failure due to pipe line debris lodged in bellows. Ensure installation conforms to manufacturer's instructions.

3.2 VALVES

- A. Provide valves in piping mains and all branches and at equipment where indicated and as specified.
- B. Provide valves to permit isolation of branch piping and each equipment item from the balance of the system.
- C. Provide riser and downcomer drains above piping shutoff valves in piping 2-1/2 inches and larger. Tap and fit shutoff valve body with a 1/2-inch plugged globe valve.
- D. Provide valves unavoidably located in furred or other normally inaccessible places with access panels adequately sized for the location and located so that concealed items may be serviced, maintained, or replaced.

3.3 SUPPORTING ELEMENTS INSTALLATION

- A. Provide supporting elements in accordance with the Section 23 05 29, referenced codes and standards.
- P. Support piping from building structure. Do not support piping from roof deck or from other pipe.
- Q. Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there is no less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangars on different adjacent service lines running parallel with each other in line with each other and parallel to the lines of the building.
- R. Install piping support elements at intervals specified hereinafter, at locations not more than 3 feet from the ends of each runout, and not over 1 foot from each change in direction of piping.
- S. Base load rating for all pipe-hanger supports on insulated weight of lines filled with water and forces imposed. Deflection per span is not exceed slope gradient of pipe. Ensure supports are in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, reduce the allowable span proportionately:

PIPE SIZE	ROD SIZE	STEEL PIPE	COPPER PIPE
<u>INCHES</u>	<u>INCHES</u>	<u>FEET</u>	<u>FEET</u>
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	10	8

2-1/2 to 3-1/2	1/2	12	12
4 to 5	5/8	16	14
6	3/4	16	16
8 to 12	7/8	20	20
14 to 18	1	20	20
20 and over	1-1/4	20	20

- E. Provide vibration isolation supports where needed. Refer to Section 23 05 48 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT where A/C equipment and piping is installed.
- F. Support vertical risers independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Ensure risers have guides for lateral stability. For risers subject to expansion, provide only one rigid support at a point approximately one-third down from the top. Place clamps under fittings unless otherwise specified. Support carbon-steel pipe at each floor and at not more than 15-foot intervals for pipe 2 inches and smaller and at not more than 20-foot intervals for pipe 2-1/2 inches and larger.

3.4 PENETRATIONS

- A. Provide effective sound stopping and adequate operating clearance to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceilings where no special acoustic treatment of ceiling is provided. Finish penetrations to be compatible with surface being penetrated.
- B. Accomplish sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings by packing to high density with properly supported fibrous-glass insulation or, where ambient or surface temperatures do not exceed 120 degrees F, by foaming-in-place with self-extinguishing, 2-pound density polyurethane foam to a depth not less than 6 inches. Finish foam with a rasp. Ensure vapor barrier is not less than 1/8-inch thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, use only mineral wool with openings covered by 16-gage sheet metal.

3.5 SLEEVES

- A. Provide sleeves where piping passes through roofs, masonry, concrete walls and floors.
- B. Continuously weld sleeves passing through steel decks to the deck.
- C. Ensure sleeves that extend through floors, roofs, load bearing walls, and fire barriers are continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. Form all other sleeves by molded linear polyethylene liners or similar materials that are removable. Ensure diameter of sleeves is large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and provides a minimum 3/8-inch clearance. Install a sleeve size to accommodate mechanical and thermal motion of pipe precluding transmission of vibration to walls and the generation of noise.
- D. Pack the space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration solid with a mineral fiber conforming to ASTM C553 Type V (flexible blanket), (to 1,000 degrees F). Provide this packing wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations

where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with an elastomer caulk to a depth of 1/2 inch. Ensure all caulked surfaces are oil- and grease-free.

- G. Ensure through-penetration fire stop materials and methods are in accordance with ASTM E814 and UL 1479.
- E. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed metal components.
- F. Ensure sleeve height above roof surface is a minimum of 12 and a maximum of 18-inches.

3.6 ESCUTCHEONS

Provide escutcheons at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, provide escutcheons on both sides of the partition. Where suspended ceilings are installed, provide plates at the underside only of such ceilings. For insulated pipes, select plates large enough to fit around the insulation. Use chrome-plated escutcheons in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Firmly attach escutcheons with setscrews.

3.7 FLASHINGS

Provide flashings at penetrations of building boundaries by mechanical systems and related work.

3.8 UNDERGROUND PIPING INSTALLATION

- A. Prior to being lowered into a trench, clean all piping, visually inspected for apparent defects, and tapped with a hammer to audibly detect hidden defects.
- B. Further inspect suspect cast-ferrous piping by painting with kerosene on external surfaces to reveal cracks.
- C. Distinctly mark defective materials found using a road-traffic quality yellow paint; promptly remove defective material from the site.
- D. After conduit has been inspected, and not less than 48 hours prior to being lowered into a trench, coat all external surfaces of cast ferrous conduit with a compatible bituminous coating for protection against brackish ground water. Apply a single coat, in accordance with the manufacturer's instructions, to result in a dry-film thickness of not less than 12 mils.
- E. Ensure excavations are dry and clear of extraneous materials when pipe is being laid.
- F. Use wheel cutters for cutting of piping or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting is not permitted.
- G. Begin laying of pipe at the low point of a system. When in final acceptance position, ensure it is true to the grades and alignment indicated, with unbroken continuity of invert. Blocking and wedging is not permitted.
- H. Point bell or grooved ends of piping upstream.
- I. Make changes in direction with long sweep fittings.
- J. Provide necessary socket clamping, piers, bases, anchors, and thrust blocking. Protect rods, clamps, and bolting with a coating of bitumen.

- H. Support underground piping below supported or suspended slabs from the slab with a minimum of two supports per length of pipe. Protect supports with a coating of bitumen.
- I. On excavations that occur near and below building footings, provide backfilling material consisting of 2,000-psi cured compressive-strength concrete poured or pressure-grouted up to the level of the footing.
- J. Properly support vertical downspouts; soil, waste, and vent stacks; water risers; and similar work on approved piers at the base and provided with approved structural supports attached to building construction.

3.9 CLEANING

Flush piping with potable water until visible grease, dirt and other contaminants are removed (visual inspection).

3.10 OPERATION AND MAINTENANCE

Provide Operation and Maintenance Manuals consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Submit test data that is clear and readily legible.

3.11 PAINTING OF NEW EQUIPMENT

Factory or shop apply new equipment painting, as specified herein, and provided under each individual section.

A. Factory Painting Systems

- 1. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied withstands 125 hours in a salt-spray fog test, except that equipment located outdoors withstand 500 hours in a salt-spray fog test. Conduct salt-spray fog test in accordance with ASTM B117, and for that test the acceptance criteria is as follows: immediately after completion of the test, the inspected paint shows no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shows no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.
- 2. Ensure the film thickness of the factory painting system applied on the equipment is not less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, design the factory painting system for the temperature service.

K. Shop Painting Systems for Metal Surfaces

- 1. Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal, surfaces subject to temperatures in excess of 120 degrees F.
- 2. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Selected color of finish coat is aluminum or light gray.

- a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F receives one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.
- b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F Receives two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.
- c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F receives two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

END SECTION 23 0515

HANGERS AND SUPPORTS FOR MECHANICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 23 Section "Common Piping for HVAC" for pipe guides and anchors.
 - 3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 4. Division 23 Section "HVAC Insulation"

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.
 - 4. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 5. Trapeze pipe hangers. Include Product Data for components.
 - 6. Metal framing systems. Include Product Data for components.
 - 7. Pipe stands. Include Product Data for components.
 - 8. Equipment supports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Anvil International
 - 3. Bergen-Power Pipe Supports.
 - 4. B-Line Systems, Inc.; a division of Cooper Industries.
 - 5. Carpenter & Paterson, Inc.
 - 6. Empire Industries, Inc.
 - 7. ERICO/Michigan Hanger Co.
 - 8. Globe Pipe Hanger Products, Inc.
 - 9. Grinnell Corp.
 - 10. GS Metals Corp.
 - 11. National Pipe Hanger Corporation.
 - 12. PHD Manufacturing, Inc.
 - 13. PHS Industries, Inc.
 - 14. Piping Technology & Products, Inc.
 - 15. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.

3. GS Metals Corp.
 4. Power-Strut Div.; Tyco International, Ltd.
 5. Thomas & Betts Corporation.
 6. Tolco Inc.
 7. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available Manufacturers:
1. Carpenter & Paterson, Inc.
 2. ERICO/Michigan Hanger Co.
 3. PHS Industries, Inc.
 4. Pipe Shields, Inc.
 5. Rilco Manufacturing Company, Inc.
 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Available Manufacturers:
1. Hilti, Inc.
 2. ITW Ramset/Red Head.
 3. Masterset Fastening Systems, Inc.
 4. MKT Fastening, LLC.

5. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Empire Industries, Inc.
3. Hilti, Inc.
4. ITW Ramset/Red Head.
5. MKT Fastening, LLC.
6. Powers Fasteners.

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

2.8 EQUIPMENT SUPPORTS

- A. A. Description: Welded, shop- or field-fabricated equipment support made from structural steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for copper piping or other piping that is subject to scratching.
- F. Hangers and supports for piping connected in conjunction with rotating or reciprocating equipment shall be spring hangers and supports for a distance of 100-pipe diameters, or a distance of three hangers away from rotating or reciprocating equipment whichever is greater. Isolators shall be as specified under Section 230548 – Vibration and Seismic Controls for HVAC Piping and Equipment.
- G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 4. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 5. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 6. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 7. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 - 8. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

10. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 11. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- H. Vertical-Piping Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
 3. Piping larger than 4", of lengths exceeding 30 feet, shall be additionally supported on base elbows secured to the building structure, with flexible supporting hangers, provided at top of riser to allow for pipe expansion.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with barjoistconstruction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 5. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 6. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
- M. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

- N. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- O. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 2. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 3. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Support apparatus and material for all conditions of operation, including variations in installed and operating weight of equipment and piping.

- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments within 1 foot of elbows and at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- O. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 40 thermal-hanger protective shields if insulation without vapor barrier is indicated. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1 inch.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END SECTION 23 05 29

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DIVISION 23 – MECHANICAL
SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S2.40 (1984; R 2001) Mechanical Vibration of Rotating and Reciprocating Machinery - Requirements for Instruments for Measuring Vibration Severity

ASA S2.71 (1983; R 2006) Guide to the Evaluation of Human Exposure to Vibration in Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE HVAC APP IP HDBK (2007; Errata 2010) HVAC Applications Handbook, I-P Edition

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB PROCEDURAL STANDARDS (2005) Procedural Standards for Testing, Adjusting and Balancing (TAB) of Environmental Systems

1.2 GENERAL REQUIREMENTS

Section [23 00 00](#) AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section to the extent applicable.

All vibration-control apparatus must be the product of a single manufacturing source, where possible. Human exposure levels should be considered using ASA S2.71 and NEBB PROCEDURAL STANDARDS.

Scheduled isolation mounting is in inches and is a minimum static deflection.

Spans referred to in Part 2, "Vibration-Isolation Systems Application," must mean longest bay dimension.

Determine exact mounting sizes and number of isolators by the isolator manufacturer based on equipment that will be installed. Check equipment revolutions per minute (rpm) and spring deflections to verify that resonance cannot occur.

Five working days prior to commencement of installation, submit installation drawings for vibration isolator systems including equipment and performance requirements.

Indicate within outline drawings for vibration isolator systems, overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Within 14 working days of Contract Award, submit equipment and performance data for vibration isolator systems including equipment base design; inertia-block mass relative to support equipment weight; spring loads and free, operating, and solid heights of spring; spring diameters; nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.

Ensure data includes the following:

- a. Mountings
- b. Bases
- c. Isolators
- d. Floor-Mounted Piping
- e. Vertical Piping

1.3 SUBMITTALS

Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

As-Built Drawings

Installation Drawings
Outline Drawings

Product Data

Equipment and Performance Data
Isolators

PART 2 PRODUCTS

2.1 TYPE OF VIBRATION-ISOLATION PROVISIONS

Design for vibration isolation using ASHRAE HVAC APP IP HDBK, Chapter 37, as applicable to the following sections.

Submit test reports for testing vibration isolation for each type of isolator and each type of base, and meet referenced standards contained within this section. Include in test reports allowable deflection and measured deflection also meeting referenced standards within this section.

A. Materials

1. Rubber must be natural rubber. Elastomer must be chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.
2. Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.
3. Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

B. Mountings

1. Provide the following mountings:
2. Type A: Composite pad, with 0.25-inch thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading must not exceed 40 pounds per square inch (psi). Minimum overall thickness must be 1 inch. Maximum deflections up to 0.25-inch are allowed.

C. Bases

Provide the following bases:

1. Type U: Unit isolators without rails, structural-steel bases, or inertia blocks.
2. Type CIB: Concrete inertia blocks must be common to the entire assembly, and have welded-joint construction, mill-rolled structural-steel perimeters, welded-in No. 4 reinforcing bars 8 inches on center each way near the bottom of the block, outrigger-isolator mounting provisions, anchor bolts, and be filled with 3,000 psi cured-strength concrete.
3. Configuration of inertia bases must be rectangular to accommodate equipment supported.
4. Minimum thickness of inertia base, in addition to providing suitable mass, must be sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Minimum thickness must be sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Minimum thickness, the preceding requirements notwithstanding, must be 8 percent of the longest base dimension.
5. Pumps with flexible couplings must not have inertia bases less than 8 inches thick.
6. Minimum mass of concrete inertia block must be equal in weight to supported equipment.

2.2 VIBRATION-ISOLATION SYSTEMS APPLICATION

Vibration isolation design per ASHRAE HVAC APP IP HDBK, Chapter 37, and ASA S2.40.

2.3 NOISE CONTROL RTU CURB CONSTRUCTION

- A. Silencing elements shall be constructed of ASTM A 653/A 653M G90 galvanized steel, with fiberglass acoustic media fill protected from erosion by a perforated steel liner. Where indicated on the silencer schedule, media shall be encapsulated in glass fiber cloth or Vibar™ film to help prevent shedding, erosion and impregnation of the glass fiber.

- B. The curb shall be constructed from a minimum of 16 ga G90 galvanized perimeter steel with a factory attached wood nailer. The perimeter steel seams shall be continuously welded. The galvanized perimeter curb steel shall be attached to a structural steel frame that incorporates a minimum of 4 restrained spring isolators that support the rooftop unit.
- C. The curb shall have factory installed lifting points
- D. Curb sides and ends shall be capable of accepting 51 mm (2") external insulation, factory installed.
- E. The isolation springs shall be of the vertical and laterally restrained type. The springs shall be designed to be laterally stable and properly selected to provide minimum specified deflection with 50% additional travel to solid. Isolation springs shall be powder coated for corrosion resistance and have a minimum static spring deflection of 25 mm (1") or 51 mm (2") or 76 mm (3") or greater as scheduled.
- F. Overhung condensing unit sections shall be supported by a structural steel pedestal assembly with isolation springs that are vertically and laterally restrained and shall be installed as the main curb section.
- G. A galvanized and insulated pan shall be provided under condensing sections that are located within the curb perimeter.
- H. The curb section shall be complete with factory installed duct supports.
- I. The curb section shall be complete with factory installed supply air and return air neoprene flex connections.
- J. Curb access doors or sections shall be installed as required for servicing curb components or accessories.
- K. The curb shall be constructed to match the pitch of the roof.
- L. The isolation shall allow 6 mm (¼") movement before resisting wind loads in any lateral direction.
- M. Where required by the project specification the isolation curb shall be designed to meet all seismic loads and wind loading as defined by the building code having jurisdiction.
- N. The perimeter of the curb shall have a flexible neoprene air and weather seal joining the upper and lower curb sections. There shall also be a continuous closed cell sponge material between the top of the spring isolation curb and underside of the rooftop unit to provide a waterproof seal.
- O. The spring isolation curb shall be shipped pre-assembled where possible. Where size prohibits one piece shipping, the isolation curb shall be split into a minimum number of sections and all connecting hardware shall be supplied by the manufacture. Additional acoustic accessories shall be shipped loose for field installation.

- P. The curb shall be insulated to meet the 2016 IECC and include a piping enclosure to match the rooftop unit.
- Q. Where required the curb shall be equipped with a 914 mm (36") wide service platform. That includes – handrails, stairs and an open grating walkway.
- R. All acoustic installation hardware shall be provided by the isolation curb manufacturer.

2.4 PIPE AND DUCT VIBRATION ISOLATION

Provide isolators with contained chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 3/8 inch.

A. Floor-Mounted Piping

Provide isolators with floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum spring static deflection of 1 inch.

B. Vertical Piping

Isolators must be elastomer mounted baseplate and riser pipe-guide devices. Elastomer elements must be contained double acting, and elastomers under rated load must have a minimum static deflection of 3/8 inch. Size isolator to accommodate thermal insulation within the stationary guide ring.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations.
- B. Rails, structural steel bases, and concrete inertia blocks must be raised not less than 1 inch above the floor and be level when equipment supported is under operating load.
- C. Ensure vibration-isolation installation and deflection testing after equipment start-up is directed by a competent representative of the manufacturer.

3.2 TESTS AND REPORTS

Ensure vibration-isolation devices are deflection tested. Submit test reports in accordance with paragraph entitled, "Submittal Procedures," substantiating that all equipment has been isolated as specified and that minimum specified deflections have been met. Make all measurements in the presence of the Architect.

END SECTION 23 05 48

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DIVISION 23 – MECHANICAL
SECTION 23 05 53
IDENTIFICATION FOR MECHANICAL

PART 1 **GENERAL**

1.1 **RELATED DOCUMENTS**

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

1.2 **SUMMARY**

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.

1.3 **SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 **COORDINATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 1 inch high.
6. Minimum Letter Size: 1/2 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering twothirdsto three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11inchbond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Adhesive backed pressure sensitive stickers. Water resistant laminate.

B. Letter Color: Red.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 1 inch high.

F. Minimum Letter Size: 1/2 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction or spray on painted stenciling, depending on location. Labels shall meet ASME/ANSI standards. Manufacturers:
 - 1. Kolbi
 - 2. Duralabel
 - 3. Brady
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on drawings and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high. All lettering shall meet ASME/ANSI standards for pipe marking.

2.4 DUCT LABELS

- A. Material and Thickness: Adhesive backed pressure sensitive stickers. Water resistant laminate.
- B. Letter Color: Red.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 1 inch high.
- F. Minimum Letter Size: 1/2 inch.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Used for identifying fire, smoke and fire/smoke damper locations.
 - 1. Labels shall state the following:
 - FIRE DAMPER
 - SMOKE DAMPER

FIRE/SMOKE DAMPER

2.5 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, pipe labels and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link, beaded chain, cable tie; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Reinforced grommet and wire or plastic tie-wrap.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Color Coding Scheme for Locating Hidden Utility Components

1. Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated below:

Color	System	Location
Green	Hydronic Water	At all Directions Changes and Valve Locations
Yellow	VAV/Controls	VAV Boxes, Control Damper Locations

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Labels: Provide stenciled labels on each piping system for piping systems in concealed vertical chases, above removable finished ceilings and on piping exposed in the upper occupied levels of the building. Exposed visible piping in the upper levels shall into be stenciled in areas only where the stenciling would not be visible.
 1. Identification Paint: Use for contrasting background.
 2. Stencil Paint: Use for pipe marking.

- B. Locate pipe labels on piping where the piping is exposed in mechanical rooms and on exposed main piping in service corridors.
- C. Piping identification shall conform to the following:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
 - 7. Once per room.
 - 8. Include flow direction arrows, whether stenciled or labeled.
- D. Pipe Label Color Schedule:
 - 1. Hydronic-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - c. Text: HTG WATER SUPPLY
HTG WATER RETURN
 - 2. Domestic-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - c. Text: COLD WATER
HOT WATER
HOT WATER RECIRC
 - 3. Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - c. Text: NATURAL GAS
 - 4. Refrigerant Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.
 - c. Text: REF LIQUID

REF SUCTION

5. Condensate Drain Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - c. Text: COND DRAIN

3.4 DUCT LABEL INSTALLATION

- A. Locate labels at points where ducts contain fire, smoke or fire/smoke dampers.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape: 1-1/2 inches, round.
 2. Valve-Tag Color: Natural brass finish.
 3. Letter Color: Black.
 4. Identify valve tags as follows:

PIPING VALVES

Domestic Cold Water Supply (DCW) CW-1, CW-2, CW-3, etc.

Domestic Hot Water (DHW) HW-1, HW-2, HW-3, etc.

Heating Water Supply (HWS) HWS-1, HWS-2, HWS-3, etc.

Heating Water Return (HWR) HWR-1, HWR-2, HWR-3, etc.

Condenser Water Supply (CWS) CWS-1, CWS-2, CWS-3, etc.

Condenser Water Return (CWR) CWR-1, CWR-2, CWR-3, etc.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 EQUIPMENT FACTORY INSTALLED NAMEPLATES

- A. Factory installed nameplates shall be located for easy reading. Relocate or provide new nameplates on motors if they are not located for easy reading.

END SECTION 23 05 53

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DIVISION 23 – MECHANICAL
SECTION 23 05 93
TESTING, ADJUSTING, & BALANCING FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.11 (2004; Errata 2005) Specification for Octave- Band and Fractional-Octave-Band Analog and Digital Filters (ASA 65)

ASA S1.4 (1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE HVAC APP IP HDBK (2007; Errata 2010) HVAC Applications Handbook, I-P Edition

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (2002; 6th ed) National Standards for Total System Balance

AABC MN-4 (1996) Test and Balance Procedures

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV (2006) Procedural Standards for Measurements of Sound and Vibration; 2nd Edition

NEBB PROCEDURAL STANDARDS (2005) Procedural Standards for Testing, Adjusting and Balancing (TAB) of Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL
ASSOCIATION (SMACNA)

SMACNA 1143 (1985) HVAC Air Duct Leakage Test Manual, 1st Edition

SMACNA 1780 (2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. OTR: Owner's Technical Representative.
- C. DALT: Duct air leakage test
- D. DALT'd: Duct air leakage tested
- E. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling.
- F. NEBB: National Environmental Balancing Bureau
- G. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."
- H. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.
- I. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.
- J. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.
- K. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).
- L. TAB: Testing, adjusting, and balancing (of HVAC systems).
- M. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed.
- N. TAB Agency: TAB Firm
- O. TAB team field leader: TAB team field leader
- P. TAB team supervisor: TAB team engineer.
- Q. TAB team technicians: TAB team assistants.
- R. TABB: Testing Adjusting and Balancing Bureau.

1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of heating, ventilating, and cooling (HVAC) air and water distribution systems including ducts, and piping which are located within, on, under, between, and adjacent to buildings.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

Conduct DALT and TAB of the systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1143, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

A. Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Owner's written approval before applying insulation to exterior of air distribution systems as specified under Section [23 0700 THERMAL INSULATION FOR MECHANICAL SYSTEMS](#).

1.4 QUALITY ASSURANCE

A. Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Architect for approval:

1. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

2. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.
3. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Owner.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section.

3.2 PRE-DALT/TAB MEETING

Meet with the Owner's Technical Representative (OTR) and the designing engineer of the HVAC systems to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

3.3 DALT PROCEDURES

A. Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

B. Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Owner in writing prior to the OTR's duct selection field visit.

C. Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the OTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will

include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

D. DALT Testing

1. Perform DALT on the HVAC duct sections of each system as selected by the OTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1143.
2. In spite of specifications of SMACNA 1143 to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the OTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

E. Quality Assurance - OTR DALT Field Acceptance Testing

1. In the presence of the OTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the OTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.
2. Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the OTR.

F. Additional OTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the OTR.

G. Certified Final DALT Report

H. Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.4 TAB PROCEDURES

A. TAB Field Work

1. Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.
2. That is, comply with the requirements of AABC MN-1, or SMACNA 1780 (TABB) and SMACNA 1858 (TABB), except as supplemented and modified by this section.

3. Provide all instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

B. Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

C. TAB Air Distribution Systems

1. Units With Coils

- a. Report heating and cooling performance capacity tests for hot water, chilled water, DX and steam coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:
- b. For units with capacities of 5 tons (100,000 Btu) or less, such as furnaces, fan coil units, duct mounted fans, and unitary units, such as through-the-wall heat pumps:
- c. Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

2. Air Handling Units

Air handling unit systems including fans (gas fired furnace fans, exhaust fans and duct fans), coils, ducts, plenums, mixing boxes, terminal units, variable air volume boxes, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

3. Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

D. TAB Work on Performance Tests Without Seasonal Limitations

1. Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.

2. Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb

temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

E. Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Owner for direction.

F. Deficiencies

1. Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph entitled "Workmanship," provide written notice as soon as possible to the Contractor and the Owner describing the deficiency and recommended correction.
2. Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

G. Quality Assurance - OTR TAB Field Acceptance Testing

1. TAB Field Acceptance Testing

- a. During the field acceptance testing, verify, in the presence of the OTR, random selections of data (water, air quantities, air motion, recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the OTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.
- b. Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: All boilers, pumps, air handling units (rooftop and central stations), and exhaust fans.

Group 2: All fin tube convectors, convectors, coils, and unit heaters.

Group 3: All return grilles, return registers, exhaust grilles and exhaust registers.

Group 4: All supply grilles and supply registers.
- c. Further, if any data on the TAB Report for Groups 1 through 4 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the OTR. Verify TAB Report

data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

2. Additional OTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the OTR.

3. Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Owner approval of the TAB Report submitted.

3.5 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.6 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

END SECTION 23 05 93

THERMAL INSULATION FOR MECHANICAL SYSTEMS**PART 1 GENERAL****1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Owner, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 189.1	(2011; Errata 2012; Errata 2012; Errata 2013; Supp 2013; Errata 2013) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - IP	(2010; Errata 1-3 2011; INT 1-12 2011; Addenda A, B, C, G, H, J, K, O, P, S, Y, Z, BZ, CG, CI and DS 2012; Errata 4-8 2012; INT 13-16 2012; Errata 9-12 2013; INT 17 2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.2	(2007; Addendum B 2010) Energy Efficient Design of Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2012a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A580/A580M	(2013) Standard Specification for Stainless Steel Wire
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C1126	(2012a) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation

ASTM C1136	(2012) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1290	(2011) Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
ASTM C1710	(2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C450	(2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C533	(2013) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534/C534M	(2011) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2012) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2012b) Standard Specification for Cellular Glass Thermal Insulation
ASTM C585	(2010) Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
ASTM C610	(2011) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C612	(2010) Mineral Fiber Block and Board Thermal Insulation
ASTM C647	(2008) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C795	(2008; R 2013) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(1985; R 2007) Standard Specification for Adhesives for Duct Thermal Insulation

ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM D2863	(2012) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM E2231	(2009) Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
ASTM E2336	(2004; R 2009) Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems
ASTM E84	(2012c) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2012) Standard Test Methods for Water Vapor Transmission of Materials
FM GLOBAL (FM)	
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
INTERNATIONAL CODE COUNCIL (ICC)	
IECC	(2009) International Energy Conservation Code
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)	
ISO 2758	(2001) Paper - Determination of Bursting Strength
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)	

MSS SP-69 (2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds (1999) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (2012) Standard for the Installation of Air Conditioning and Ventilating Systems

NFPA 90B (2012) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

NFPA 96 (2011) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T403 OM (2010) Bursting Strength of Paper

UNDERWRITERS LABORATORIES (UL)

UL 723 (2008; Reprint Sep 2010) Test for Surface Burning Characteristics of Building Materials

UL 94 (2013) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 SYSTEM DESCRIPTION

A. General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Owner-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 SUBMITTALS

Submittals are for Contractor Quality Control approval. Submit the following in accordance with Section [01 3000](#) SUBMITTAL PROCEDURES, for submittal procedures:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

Shop Drawings

Duct Insulation Systems and Associated Accessories

Pipe Insulation systems and Associated Accessories

Product Data

Duct Insulation Systems

Pipe Insulation Systems

Manufacturer's Instructions

Duct Insulation Systems

Pipe Insulation Systems

1.4 QUALITY ASSURANCE

A. Installer Qualification

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The contractor may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable). Insulation packages and containers shall be asbestos free.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and

shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet.

B. Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Insulation shall be CFC and HCFC free.

C. Surface Burning Characteristics

Unless otherwise specified, insulation shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Test specimens shall be prepared and mounted according to ASTM E2231.

2.2 MATERIALS

Provide insulation that meets or exceeds the requirements of ASHRAE 90.1 and 2012 International Energy Conservation Code. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C795 requirements. Calcium silicate shall not be used on chilled or cold water systems. Materials shall be asbestos free. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

A. Adhesives

1. Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

2. Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. To resist mold/mildew, lagging adhesive shall meet ASTM D5590 with 0 growth rating. Lagging adhesives shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Adhesive shall be MIL-A-3316, Class 1 and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching

fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

3. Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

B. Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

C. Corner Angles

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209, Alloy 3003, 3105, or 5005.

D. Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, properly installed protective vapor retarder/barriers and vapor stops shall be used on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

E. Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

F. Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

G. Staples

Outward clinching type ASTM A167, Type 304 or 316 stainless steel.

H. Jackets

1. Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2. Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.

3. Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

- a. On ducts, piping and equipment operating below 32 degrees F or located outside shall be equipped with a vapor barrier.
- b. Ducts, pipes and equipment that are located inside and that always operate above 180 degrees F shall be installed with a vapor retarder where required as stated in paragraph VAPOR RETARDER REQUIRED.

I. Vapor Retarder Required

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are cellular glass, when all joints

are sealed with a vapor barrier mastic, and mineral fiber. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

4. White Vapor Retarder All Service Jacket (ASJ)

- a. ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. The product shall meet all physical property and performance requirements of ASTM C1136, Type I, except the burst strength shall be a minimum of 85 psi. ASTM D2863 Limited Oxygen Index (LOI) shall be a minimum of 31.
- b. In addition, neither the outer exposed surface nor the inner-most surface contacting the insulation shall be paper or other moisture-sensitive material. The outer exposed surface shall be white and have an emittance of not less than 0.80. The outer exposed surface shall be paintable.

5. Vapor Retarder/Vapor Barrier Mastic Coatings

- a. The vapor barrier shall be self adhesive (minimum 2 mils adhesive, 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Permeability shall be less than 0.02 when tested in accordance with ASTM E96/E96M. Products shall meet UL 723 or ASTM E84 flame and smoke requirements and shall be UV resistant.
- b. The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be 0.013 perms or less at 43 mils dry film thickness as determined according to procedure B of ASTM E96/E96M utilizing apparatus described in ASTM E96/E96M. The coating shall be nonflammable, fire resistant type. Coating shall meet MIL-PRF-19565 Type II (if selected for indoor service) and be Qualified Products Database listed. All other application and service properties shall be in accordance with ASTM C647.

6. Laminated Film Vapor Retarder

ASTM C1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Vapor retarder shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible Elastomeric exterior foam with factory applied UV Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

7. Polyvinylidene Chloride (PVDC) Film Vapor Retarder

The PVDC film vapor retarder shall have a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 30 lb/inch when tested in accordance with ASTM D882, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

8. Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

9. Vapor Barrier/Weather Barrier

The vapor barrier shall be greater than 3 ply self adhesive laminate -white vapor barrier jacket- superior performance (less than 0.0000 permeability when tested in accordance with ASTM E96/E96M). Vapor barrier shall meet UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 185 psi in accordance with ISO 2758. Tensile strength 68 lb/inch width (PSTC-1000). Tape shall be as specified for laminated film vapor barrier above.

J. Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Jacket shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

K. Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

L. Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

M. Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 DUCT INSULATION SYSTEMS

A. Factory Applied Insulation

Provide factory-applied ASTM C552, cellular glass thermal or ASTM C534/C534M Grade 1, Type II, flexible elastomeric closed cell insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-

retardant vapor barrier, with identification of installed thermal resistance (R) value and out-of-package R value.

1. Rigid Insulation

Rigid mineral fiber in accordance with ASTM C612, Class 2 (maximum surface temperature 400 degrees F), 3 pcf average, 1-1/2 inch thick, Type IA, IB, II, III, and IV.

2. Blanket Insulation

Blanket flexible mineral fiber insulation conforming to ASTM C585, Type 1, Class B-3, 3/4 pcf nominal, 2.0 inches thick or Type II up to 250 degrees F. Also ASTM C1290 Type III may be used.

B. Duct Insulation Jackets

1. All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.

2. Metal Jackets

- a. Aluminum Jackets: ASTM B209, Temper H14, minimum thickness of 27 gauge (0.016 inch), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension 8 inches and larger. Provide corrugated surface jackets for jacket outside dimension 8 inches and larger. Provide stainless steel bands, minimum width of 1/2 inch.
- b. Stainless Steel Jackets: ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2 inch.

3. Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty white or natural).

C. Acoustical Duct Lining

1. General

For ductwork indicated or specified in Section [23 0000](#) AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM to be acoustically lined, provide external insulation in accordance with this specification section and in addition to the acoustical

duct lining. Do not use acoustical lining in place of duct wrap or rigid board insulation (insulation on the exterior of the duct).

2. Duct Liner

Flexible Elastomeric Acoustical and Conformable Duct Liner: Materials: Flexible Elastomeric Thermal, Acoustical and Conformable Insulation Compliance with ASTM C534/C534M Grade 1, Type II or ASTM C1534 and NFPA 90A or NFPA 90B.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

A. Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

B. Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A and/or NFPA 90B. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

C. Painting and Finishing

Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

D. Welding

No welding shall be done on piping or duct without written approval of the engineer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

E. Pipes/Ducts/ That Require Insulation

Insulation is required on all pipes and ducts, per the 2012 International Energy Conservation Code.

3.2 DUCT INSULATION SYSTEMS INSTALLATION

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Duct insulation shall be omitted on exposed supply and return ducts in air conditioned spaces. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

Duct insulation minimum R-value shall be in accordance with Table 4 and 2015 International Energy Conservation Code.

Table 4 - Minimum R-value for Duct Insulation	
Supply Ducts Located Outside Building Envelope	R-8
All Other Ducts	R-6

A. Insulation and Vapor Retarder/Vapor Barrier for Cold/Warm Air Ducts

Insulation and vapor retarder/vapor barrier shall be provided for the following cold/warm air ducts and associated equipment.

1. Supply ducts.
2. Return air ducts.
3. Flexible run-outs (field-insulated).
4. Duct-mounted coil casings.
5. Fresh air intake ducts.
6. Filter boxes.
7. Mixing boxes (field-insulated).
8. Exhaust ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf, and rigid type where exposed, minimum density 3 pcf. Insulation for both concealed or exposed round/oval ducts shall be flexible type, minimum density 3/4 pcf or a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Insulation for all exposed ducts shall be provided with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified, the total field applied dry film thickness shall be approximately 1/16 inch. Insulation on all concealed duct shall be provided with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Duct insulation shall be continuous through sleeves and prepared openings except firewall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder/vapor barrier shall cover the collar, neck, and any uninsulated surfaces of diffusers, registers and grills. Vapor retarder/vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with Section [23 0000](#) AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

9. Installation on Concealed Duct

- a. For rectangular, oval or round ducts, flexible insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.
- b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
- c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
- d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.
- e. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over.
- f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.
- g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond

the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

- h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.
- i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.
- j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

10. Installation on Exposed Duct Work

- a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches. Mechanical fasteners shall be as corrosion resistant as G60 coated galvanized steel, and shall indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall.
- b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder/barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over. Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.
- c. Impale insulation on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.
- d. Seal joints in the insulation jacket with a 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.
- e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape

and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.

- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a flashing sealant.
- g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.
- h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as in accordance with MICA standards.

B. Insulation for Evaporative Cooling Duct

Evaporative cooling supply duct located in spaces not evaporatively cooled, shall be insulated. Material and installation requirements shall be as specified for duct insulation for warm air duct.

C. Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3 PIPE INSULATION SYSTEMS INSTALLATION

Install pipe insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

A. Pipe Insulation

1. General

Pipe insulation shall be installed on aboveground heating hot water pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used.

2. Pipes Passing Through Walls, Roofs, and Floors

- a. Pipe insulation shall be continuous through the sleeve.
- b. An aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory

applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.

- c. Where pipes penetrate interior walls, the aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.
- d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.
- e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.
- f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.
- g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

3. Pipes Passing Through Hangers

- a. Insulation shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.
- b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and Section [22 0000](#) PLUMBING, GENERAL PURPOSE.
- c. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the

insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

- d. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

4. Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Grade 1, Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

5. Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket, - less than 0.0000 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected.

6. Pipe Insulation Material and Thickness

Table 1

Fluid Operating Temp Range and Usage (deg F)	Insulation Conductivity		Nominal Pipe Size (Inches)				
	Conductivity (Btu-in)/(h-ft ² -deg F)	Mean Rating Temp (Deg F)	<1	1 to <1.5	1.5to <4	4 to <8	<8
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20-0.26	75	0.5	1.0	1.0	1.0	1.5

Reference: ICC 2015 International Energy Conservation Code.

B. Aboveground Hot Pipelines

1. General Requirements

- All hot water heating pipe lines above 60 degrees F, shall be insulated in accordance with Table 1.
- Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.

2. Insulation for Fittings and Accessories

- General. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant. Insulation shall be marked showing the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.
- Precut or Preformed. Precut or preformed insulation shall be placed around all fittings and accessories. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.
- Rigid Preformed. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3. Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

4. Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed, and UV resistant).

5. PVC Jacket

PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

END SECTION 23 07 00

COMMISSIONING OF HVAC SYSTEMS**PART 1 - GENERAL****1.1 REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline (2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard (2009) Procedural Standards for Whole Building Systems Commissioning of New Construction; 3rd Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1429 (1994) HVAC Systems Commissioning Manual, 1st Edition

1.2 DEFINITIONS

In some instances, terminology differs between the Contract and the Commissioning Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding ACG, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	ACG	NEBB	TABB
Commissioning Standard	ACG Commissioning Guideline	Procedural Standards for Building Systems Commissioning	SMACNA HVAC Commissioning Guidelines
Commissioning Specialist	ACG Certified Commissioning Agent	NEBB Qualified Commissioning Administrator	TABB Certified Commissioning Supervisor

1.3 SYSTEM DESCRIPTION

A. General

1. Perform Commissioning in accordance with the requirements of the standard under which the Commissioning Firm's qualifications are approved, i.e., ACG Commissioning Guideline, NEBB Commissioning Standard, or SMACNA 1429 unless otherwise stated herein. Consider mandatory all recommendations and suggested practices contained in the Commissioning Standard. Use the Commissioning Standard for all aspects of Commissioning, including qualifications for the Commissioning Firm and Specialist and calibration of Commissioning instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the Commissioning Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the Commissioning Standard, Commissioning procedures shall be developed by the Commissioning Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the Commissioning Standard used (ACG, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

B. Energy

1. Formal LEED NC certification is not required; however, the Contractor is required to provide documentation that meets the LEED NC Energy & Atmosphere (EA) Prerequisite 1, Fundamental Commissioning. For New Construction and Major Revisions provide, also, documentation that meets EA Credit 3; Enhanced Commissioning.

1.4 SUBMITTALS

Submit the following in accordance with Section [013300](#) SUBMITTAL PROCEDURES:

Shop Drawings

Commissioning Plan

Product Data

Pre-Functional Performance Test Checklists
Functional Performance Tests

Test Reports

Commissioning Report

Certificates

Commissioning Firm
Commissioning Specialist

1.5 QUALITY ASSURANCE

A. Commissioning Firm

1. Submit certification of the proposed Commissioning Firm's qualifications to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. The firm is either a member of ACG or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Firm shall be described in detail. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, immediately notify the Owner and submit another Commissioning Firm for approval. Any firm that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections to be performed by the Commissioning Firm shall be considered invalid if the Commissioning Firm loses its certification prior to Contract completion and must be performed by an approved successor. These Commissioning services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The Commissioning Firm shall be a subcontractor of the prime Contractor and shall be financially and corporately independent of all other sub-Contractors. The Commissioning Firm shall report to and be paid by the prime Contractor.

B. Commissioning Specialist

1. General: Submit certification of the proposed Commissioning Specialist's qualifications to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date when the current Certification expires. The Commissioning Specialist shall be an ACG Certified Commissioning Agent, a NEBB Qualified Commissioning Administrator, or a TABB Certified Commissioning Supervisor and shall be an employee of the approved Commissioning Firm. Any lapses in Certification of the proposed Commissioning Specialist or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Specialist shall be described in detail. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Commissioning Specialist loses subject certification during this period, immediately notify the Owner and submit another Commissioning Specialist for approval. Any individual that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections performed by the Commissioning Specialist shall be considered invalid if the Commissioning Specialist loses certification prior to Contract completion and must be performed by the approved successor.
2. Responsibilities: Perform all Commissioning work specified herein and in related sections under the direct guidance of the Commissioning Specialist. The Commissioning Specialist shall prepare, no later than 28 days after the approval of the Commissioning Specialist, the Commissioning Plan which will be a comprehensive schedule and will include all submittal requirements for procedures, notifications, reports and the

Commissioning Report. After approval of the Commissioning Plan, revise the Contract NAS schedule to reflect the schedule requirements in the Commissioning Plan.

1.6 SEQUENCING AND SCHEDULING

- A. Begin the work described in this Section only after all work required in related Sections has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Pre-Functional Performance Test Checklists shall be performed at appropriate times during the construction phase of the Contract.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 COMMISSIONING TEAM AND TEST FORMS AND CHECKLISTS

- A. Designate Contractor team members to participate in the Pre- Functional Performance Test Checklists and the Functional Performance Tests specified herein. In addition, the Owner team members will include a representative of the Owner, the Design Agent's Representative, and the District Representative. The team members shall be as follows:

Designation	Function
A	Contractor's Commissioning Specialist
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing (TAB) Specialist
C	Contractor's Controls Representative
D	Design Agency Representative
O	Owner's Representative
U	District Representative

Appendices A and B are provided as templates for testing; tailored test script shall be developed and completed by the commissioning team. Acceptance by each commissioning team member of each Pre- Functional Performance Test Checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test item shall be indicated by signature and date.

1.7 TESTS

Perform the pre-functional performance test checklists and functional performance tests in a manner that essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, establish methods which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. Provide all materials, services, and labor required to perform the pre- functional performance tests checks and functional performance tests. A functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Owner commissioning team member of which participation is specified is not present for the test.

B. Pre-Functional Performance Test Checklists

Perform Pre-Functional Performance Test Checklists, for the items indicated in Appendix A, at least 28 days prior to the start of Pre-Functional Performance Test Checks. Correct and re-inspect deficiencies discovered during these checks in accordance with the applicable contract requirements. Submit the schedule for the test checks at least 14 days prior to the start of Pre-Functional Performance Test Checks.

C. Functional Performance Tests

Submit test procedures at least 28 days prior to the start of Functional Performance Tests. Submit the schedule for the tests at least 14 days prior to the start of Functional Performance Tests. Perform Functional Performance Tests for the items indicated in Appendix B. Begin Functional Performance Tests only after all Pre-Functional Performance Test Checklists have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Begin Tests with equipment or components and progress through subsystems to complete systems. Upon failure of any Functional Performance Test item, correct all deficiencies in accordance with the applicable contract requirements. The item shall then be retested until it has been completed with no errors.

1.8 COMMISSIONING REPORT

Submit the Commissioning Report, no later than 14 days after completion of Functional Performance Tests, consisting of completed Pre- Functional Performance Test Checklists and completed Functional Performance Tests organized by system and by subsystem and submitted as one package. The Commissioning Report shall also include all HVAC systems test reports, inspection reports (Preparatory, Initial and Follow-up inspections), start-up reports, TAB report, TAB verification report, Controls start-up test reports and Controls Performance Verification Test (PVT) report. The results of failed tests shall be included along with a description of the corrective action taken.

APPENDIX A

PRE-FUNCTIONAL PERFORMANCE TEST CHECKLISTS

Pre-Functional Performance Test Checklist - Rooftop Unit

For Air Handling Unit: [_____]

Checklist Item	A	M	E	T	C	O
Installation						
a. Inspection and access doors are operable and sealed.	___	___	X	___	X	___
b. Condensate drainage is unobstructed. (Visually verify pan drains completely by pouring a cup of water into drain pan.)	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___

Electrical	A	M	E	T	C	O
a. Power available to unit disconnect.	___	X	___	X	X	___
b. Power available to unit control panel.	___	X	___	X	X	___
c. Proper motor rotation verified.	___	X	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	X	___	X	X	___
[e. Power available to electric heating coil.	___	X	___	X	X	___]

Controls	A	M	E	T	C	O
a. Control valves/actuators properly installed.	___	X	X	X	___	___
b. Control valves/actuators operable.	___	X	X	X	___	___
c. O/A dampers/actuators properly installed.	___	X	X	X	___	___
d. O/A dampers/actuators operable.	___	X	X	X	___	___

Pre-Functional Performance Test Checklist - Unit Heater

For Unit Heater: [_____]

Checklist Item

Installation

A M E T C O

a. Hot water piping properly connected. _____ X _____

Electrical

A M E T C O

a. Power available to unit disconnect. _____ X _____

b. Proper motor rotation verified. _____ X X _____

c. Verify that power disconnect is located within sight of the unit it controls. _____ X _____

d. Power available to electric heating coil. _____ X _____

Controls

A M E T C O

a. Control valves properly installed. _____ X _____

b. Control valves operable. _____ X X _____

c. Verify proper location and installation of thermostat. _____ X _____

Testing, Adjusting, and Balancing (TAB)

A M E T C O

a. TAB Report approved. _____ X _____

Pre-Functional Performance Test Checklist - HVAC System Controls

For HVAC System: [_____]

Checklist Item

Installation	A	M	E	T	C	O
a. Verify Operation of Existing Control Panel	___	___	X	X	X	___
b. Framed instructions mounted in or near control panel.	___	___	X	X	___	___
c. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___
d. Control components piped and/or wired to each labeled terminal strip.	___	___	X	X	___	___
e. EMCS connection made to each labeled terminal strip as shown.	___	___	X	X	___	___
f. Control wiring labeled at all terminations, splices, and junctions.	___	___	X	X	___	___
Main Power and Control Air						
a. 120 volt AC power available to panel.	___	___	___	X	___	___
Testing, Adjusting, and Balancing (TAB)						
a. TAB Report submitted.	___	___	X	___	X	___

- End of Appendix A -

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Rooftop Unit

For Air Handling Unit: [_____]

1. Functional Performance Test: Contractor shall verify operation of air handling unit in accordance with specification including the following:

a. Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions_____.

b. The following shall be verified [supply fan operating][supply and return fans operating] mode is initiated:

(1) All dampers in normal position prior to fan start_____.

(2) All valves in normal position prior to fan start_____.

(3) System safeties allow start if safety conditions are met._____

(4) VAV fan controller shall "soft-start" fan. _____

(5) Modulate all VAV boxes to minimum air flow and verify that the static pressure does not exceed the high static pressure shutdown setpoint_____.

(6) Return all VAV boxes to auto _____.

c. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. _____

(2) Return air damper open. _____

(3) Relief air damper [at minimum position] [closed]. _____

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point. Setpoint _____inches-wg Actual _____inches-wg

d. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. Setpoint _____deg F, Actual _____deg F, Outside air damper position _____ percent.

(2) Relief air damper modulates with outside air damper according to sequence of operation. Relief air damper position_____ percent.

(4) Hot water control valve modulating to maintain leaving air temperature set point. Setpoint _____deg F Actual _____deg F

Functional Performance Test Checklist (cont) - Rooftop Unit

(5) Fan VAV controller receives signal from duct static pressure sensor and modulates fan to maintain supply duct static pressure set point. Setpoint inches-wg_____ Actual inches-wg_____

e. Unoccupied mode of operation

(1) Observe fan starts when space temperature calls for heating and/or cooling. _____ Note: This does not apply to series boxes.

(2) All dampers in normal position. _____

(3) Verify space temperature is maintained as specified in sequence of operation. _____

f. The following shall be verified when the [supply fan off][supply and return fans off] mode is initiated:

(1) All dampers in normal position. _____

(2) All valves in normal position. _____

(3) Fan de-energizes. _____

h. Verify safety shut down initiated by low temperature protection thermostat. _____

i. Verify occupancy schedule is programmed into time BAS_____.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Owner's Representative _____

District Representative _____

Functional Performance Test Checklist - Unit Heaters

The Owner will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent. Hot water systems (for hot water unit heaters) must be in operation and supplying design hot water supply temperature water.

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters:

- a. Verify unit heater response to room temperature set point adjustment. _____
- b. Check heating mode inlet air temperature. _____ deg F
- c. Check heating mode outlet air temperature. _____ deg F
- d. Record manufacturer's submitted fan capacity _____cfm
- e. Calculate unit heater capacity using manufacturer's fan capacity and recorded temperatures and compare to design.
- f. Calculated_____BTU/hr Design_____BTU/hr

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Owner's Representative	_____
District Representative	_____

Functional Performance Test Checklist - HVAC Controls

For HVAC System: [_____]

The Owner will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed 10 percent. Perform this test simultaneously with FPT for AHU or other controlled equipment.

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the Performance Verification Test (PVT) test for that system. Contractor to provide blank PVT test procedures previously done by the controls Contractor.

2. Verify interlock with BAS system_____.

3. Verify all required I/O points function from the BAS system_____.

4. Certification: We the undersigned have witnessed the Performance Verification Test and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist _____

Contractor's Mechanical Representative _____

Contractor's Electrical Representative _____

Contractor's TAB Representative _____

Contractor's Controls Representative _____

Design Agency Representative _____

Architect's Representative _____

District Representative _____

- End of Appendix B -

END SECTION 23 08 00

INSTRUMENTATION AND CONTROL FOR MECHANICAL**PART 1 - GENERAL****1.0 SUMMARY**

- A. This Section includes a fully Integrated Building Automation System (BAS) to control HVAC systems and components, including control of all terminal heating and cooling units and other equipment not supplied with factory-supplied controls.
- B. The Building Automation System (BAS) manufacturer shall furnish and install all components to integrate new equipment into the existing school system and district wide building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified. The system integrate with power and lighting control system.
- C. The existing school BAS system JACE utilizes a BACnet open architecture (any BACnet licensing required for the JACE shall be provided by district). All new devices shall be a BACNet open architecture. The physical network for the systems, the cable plant, the logical network for the systems and the networking protocols shall be open architectures, supporting multiple applications and equipment manufacturers. The system uses an existing district wide fiber optic network for communication to the Tridium system.
- D. The school district has an existing contract with Mechanical Incorporated for the controls of all equipment. All new work is to be compatible and fully integrate with existing systems.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-D (2012) Laboratory Methods of Testing Dampers for Rating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 135 (2012; Errata 1 2013; INT 1-9 2013; Errata 2 2013; INT 10-12 2014; Errata 3 2014) BACnet—A Data Communication Protocol for Building Automation and Control Networks

ARCNET TRADE ASSOCIATION (ATA)

ATA 878.1 (1999) Local Area Network: Token Bus

ASME INTERNATIONAL (ASME)

ASME B16.18 (2012) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.22 (2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26	(2013) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2013) Valves - Flanged, Threaded and Welding End
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2014; INT 1-47) Power Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC	(2010) Boiler and Pressure Vessels Code

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B32	(2008; R 2014) Standard Specification for Solder Metal
ASTM B75/B75M	(2011) Standard Specification for Seamless Copper Tube
ASTM B88	(2014) Standard Specification for Seamless Copper Water Tube
ASTM D1238	(2013) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1693	(2013) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D638	(2010) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13	(2008; INT 2009) Standard Requirements for Instrument Transformers
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IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.45	(2002; R 2008) Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000v and less) AC Power Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8802-3	(2000) Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA/ANSI C12.10	(2011) Physical Aspects of Watthour Meters - Safety Standards
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
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UNDERWRITERS LABORATORIES (UL)

UL 1449	(2014) Surge Protective Devices
UL 506	(2008; Reprint Oct 2013) Specialty Transformers
UL 508A	(2013; Reprint Jan 2014) Industrial Control Panels
UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment

1.2 DEFINITIONS

A. DDC: Direct digital control.

- B. I/O: Input/output.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. MS/TP: Master slave/token passing.
- F. PID: Proportional plus integral plus derivative.
- G. RTD: Resistance temperature detector.
- H. RTC: Real time clock.
- I. BAS: Building Automation System.
- J. NRC: Network Router/Controller.
- K. SDCU: Stand Alone Digital Control Units.
- L. APW: Administration and Programming Workstation.
- M. WOW: Web-Based Operator Workstation.
- N. ODBC: Open Data Base Connectivity.

1.3 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 2. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 3. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 4. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 5. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 - 6. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
 - e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
 - f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
 - g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
 - h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.

- l. Airflow (Terminal): Plus or minus 10 percent of full scale.
- m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
- n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
- o. Carbon Monoxide: Plus or minus 5 percent of reading.
- p. Carbon Dioxide: Plus or minus 50 ppm.
- q. Electrical: Plus or minus 5 percent of reading.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 23

1.5 ACTION SUBMITTALS

A. Shop Drawings: Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent. When manufacturer's cut sheets apply to a product series rather than specific products, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include:

1. Direct Digital Control System Hardware:

- a. A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
- b. Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for the items listed below and other relevant items not listed below:

- 1) Direct Digital controller (controller panels).
- 2) Transducers/Transmitters.
- 3) Sensors (including accuracy data).
- 4) Actuators.
- 5) Valves.
- 6) Relays/Switches.
- 7) Control Panels.
- 8) Power Supply.
- 9) Batteries.
- 10) Wiring.

- c. Wiring diagrams and layouts for each control panel. Show all termination numbers
- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.

2. Controlled Systems:

- a. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
- b. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name. All terminals shall be labeled.

- c. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
 - d. A mounting, wiring, and routing plan-view drawing. The drawing shall be done in 1/4 inch scale. The design shall take into account HVAC, electrical and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - e. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - f. A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.
3. A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface included in the submittal.

1.6 CLOSEOUT SUBMITTALS

A. Operations and Maintenance Data:

1. Operation and Maintenance (O & M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O & M manual shall include:
- a. Names, addresses, and 24-hour telephone numbers of contractors installing equipment and the control systems and service representatives of each.
 - b. Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
 - c. One set of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
 - d. Engineering, Installation and Maintenance Manual(s) that explain how to design and install new points, panels, and the hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
 - e. A listing and documentation of all custom software created using the programming language, including the set points, tuning parameters, and object database. One set of magnetic/optical media containing files of the software and database also shall be provided.
 - f. One set of digital media containing files of the software and database also shall be provided.
 - g. A list of recommended spare parts with part numbers and suppliers.
 - h. Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.
 - i. Complete original issue digital medias for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
 - j. Licenses, guarantees, and warranty documents for all equipment and systems.
 - k. Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

- B. Project Record Documents: Upon completion of installation, submit three copies of record (asbuilt) documents. The documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. These shall be as-built versions of the submittal shop drawings. One set of digital media including CAD, .DWG, or .DXF drawing files also shall be provided.
2. Final Field Quality Control Test Reports:
3. Include locations of device on Record Drawings including addresses.

1.7 QUALITY ASSURANCE

- A. Comply with Codes and Standards listed in Paragraph 1.1.
- B. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility with 40 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.
- C. The manufacturer shall provide on site, experienced technicians for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS.
- D. The contractor shall be regularly engaged in the manufacturing, installation and maintenance of BAS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. A maintained service organization consisting of at least ten (10) competent servicemen for a period of not less than ten years and provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.
- E. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design and complies with the specification requirements.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update all devices to latest version of software at Project completion.

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate wiring of equipment with Division 28 and Division 26 to achieve compatibility of communication interfaces.
- C. Coordinate supply of conditioned electrical branch circuits for control units.
- D. Coordinate equipment with Division 26 Section "Enclosed Controllers" to achieve compatibility with starter coils and annunciation devices.
- E. Refer to other Division 23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems.
- F. Provide the following electrical work as work of this section, complying with requirements of applicable Division 26 and 27 sections:
 1. Control wiring between field-installed controls, indicating devices, and unit control panels consistent with ANSI/TIA/EIA-862.
 2. Power wiring for DDC controllers and all other control system components. Provide service from spare 20A circuit breakers in nearest power panel.

1.10 EXTRA MATERIAL

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. One replacement relay mechanism for each unique damper motor, valve motor, controller, thermostat, positioning relay.

1.11 WARRANTY

- A. Warrant all work as follows:

1. Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the owner. The contractor shall respond to the owner's requires for warranty service within 24 hours during normal business hours.
2. All work shall have a single warranty date, even when the owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
3. At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the engineer, the engineer shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.
5. Exception: The contractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The contractor shall warrant all installation labor and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of engineer's acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide all control components compatible with the existing Lewis Lemon BACnet system by:
1. Niagara JACE.
- B. Basis of design shall be BACnet. Acceptable manufacturers shall include BACnet, LonWorks, or owner approved equal during bidding.
- C. Installers: The control system shall be installed by a branch or franchise office of an acceptable manufacturer.
- D. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. Do not use this installation as a product test side unless explicitly approved in writing by an Owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. General:

1. The Building Automation System (BAS) shall consist of a family of Standalone Digital Control Units (SDCUs) connecting to the existing Niagara JACE to provide control, alarm detection, scheduling, reporting and information management for the entire facility.

B. Support For Open Systems Protocols:

1. The BAS design must include solutions for the integration of the following "open systems" protocols: LonTalk, Modbus, BACnet and digital data communication to third party microprocessors such as boiler plant controllers, fire panels and variable frequency drives (VFDs).
2. The system shall also provide the ability to program custom ASCII communication drivers that will reside in a BACnet Gateway, for communication to third party systems and devices. These drivers will provide real time monitoring and control of the third party systems. Once programmed, these data points shall be monitored and controlled in exactly the same manner as native BAS data points.

2.3 STANDALONE DIGITAL CONTROL UNITS (SDCUS)

A. General:

1. Standalone Digital Control Units shall provide control of HVAC, including air handling units, rooftop units, variable air volume boxes, unit ventilators, cabinet unit heaters, and other mechanical equipment. Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated NRC. Each SDCU provided must be a "native" BACnet device, supporting the BACnet Controller profile. Controllers that support a lesser profile such as B-SA are not acceptable. SDCUs shall be tested and certified by the BACnet Testing Laboratory as Advanced Application Controllers.

B. Memory:

1. Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.

C. Communication Ports:

1. SDCUs shall have a RS-485 communication port to the BACnet MS/TP field bus, operating at a speed of at least 76.8kbps.

D. Input/Output:

1. Each SDCU shall have enough inputs and outputs to meet the application's required points. Each SDCU shall support universal inputs, whereas any input may be software defined as:
 - a. Digital Inputs for status/alarm contacts.
 - b. Counter Inputs for summing pulses from meters.
 - c. Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
 - d. Analog inputs for pressure, humidity, flow and position measurements.
2. SDCU's must support both digital and analog output types:
 - a. Digital Outputs for on/off equipment control.
 - b. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

E. Expandability:

1. For larger controllers (16 base inputs and up), provide input and output expansion through the use of plug-in modules. At least two I/O modules must be capable of being added to the base SDCU.

F. Hardware Override Switches:

1. All digital outputs on air handling unit controllers shall include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output on air

handling unit controllers shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

G. Room Sensor Support:

1. The SDCU shall support a basic room thermostat sensor with humidistat, provided by equipment manufacturer.

H. Networking:

1. Each SDCU will be able to exchange information on a peer to peer basis with other Standalone Digital Control Units. Each SDCU shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each SDCU shall be able to have its program viewed and/or enabled/disabled through a workstation connected to an NRC.

I. Indicator Lamps:

1. SDCUs will have as a minimum, LED indication of CPU status, and field bus status.

J. Real Time Clock (RTC):

1. All SDCUs shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each SDCU shall receive a signal, every hour, over the network from the NRC, which synchronizes all SDCU real time clocks.

K. Automatic Restart After Power Failure:

1. Upon restoration of power, the SDCU shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

L. Battery Back Up:

1. All SDCUs shall store all programming in non-volatile FLASH memory. All SDCUs except terminal controllers shall include an on-board lithium battery to back up the controller's RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the SDCU shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the SDCU shall restart itself from its application program stored in its FLASH memory.

M. Software – General:

1. The SDCU shall contain FLASH memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each SDCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

N. User Programming Language:

1. The application software shall be user programmable, using the same language as that defined for existing Network Router/Controllers.
2. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Router/Controller.

O. History Logging:

1. Each controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the

point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

P. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the SDCU and can result in the display of one or more alarm messages or reports.
2. Up to 8 alarms can be configured for each point in the controller.
3. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
4. If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the controller. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.

Q. Air Handler Controllers:

1. AHU Controllers shall be capable of meeting the requirements of the sequence of operation found in the contract documents and for future expansion.
2. AHU Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
3. AHU Controllers shall be fully user programmable to allow for modification of the application software.
4. A manual override switch shall be provided for all digital and analog outputs on the AHU Controller. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

R. VVT Terminal Unit Controllers:

1. VVT Terminal Unit Controllers shall support, but not be limited to the control of the following configurations of VVT boxes to address current requirements as described in the Sequence of Operation and for future expansion:
 - a. Single Duct Cooling with Reheat (Hot Water).
2. VVT Controllers for single duct applications will come equipped with a built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 35 in.lb., and contain an override mechanism for manual positioning of the damper during startup and service.
3. VVT Controllers shall contain an integral velocity sensor accurate to +/- 5% of the full range of the box's CFM rating.
4. Each controller shall perform the described Sequence of Operation and have the capability for local time of day scheduling, occupancy mode control, after hour's operation, alarming, and trending.
5. VVT Controllers shall be able to communicate with any other Standalone Digital Control Unit on the same MS/TP field bus.

S. Unitary Controllers:

1. Unitary Controllers shall support, but not be limited to, the control of the following systems as described in the Sequence of Control and for future expansion:
 - a. Unit Ventilators.
 - b. Packaged Rooftops.
 - c. Fan Coils.
2. The I/O of each Unitary Controller shall contain the sufficient quantity and types as required to meet the Sequence of Operation found. In addition, each controller shall have the capability for local time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.

3. Unitary Controllers shall be able to communicate with any other Standalone Digital Control Unit on the same MS/TP field bus.

2.4 GATEWAY TO THIRD-PARTY DEVICES

A. General:

1. Where required, provide a Gateway to interface to non-compatible systems that use the Modbus protocol, LonWorks protocol, or other proprietary protocol. The Gateway shall communicate directly over BACnet, and shall connect to the building's central Building Controller (JACE).

B. Communication Ports:

1. In addition to its on-board Ethernet port, the Gateway shall have at least two serial communications ports for interfaces to third-party systems.

C. Memory:

1. The Gateway shall have enough RAM memory to store all point configuration data, plus required history logging and alarm buffering. Minimum RAM shall be 8MB. The operating system of the gateway must be stored in FLASH non-volatile memory.

D. User Programming Language:

1. The Gateway shall employ the same user programmable application software that NRCs and SDCUs use.
2. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Router/Controller. Gateways that do not have an application programming language will not be accepted.

E. History Logging:

1. Each Gateway shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the district Tridium system for long term archiving based upon user-defined time intervals, or manual command.

2.5 INPUT/OUTPUT INTERFACE

A. Provide instrumentation as required for monitoring, control or optimization functions.

B. Hardwired inputs and outputs may tie into the system through SDCU's.

C. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

D. Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

E. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation. F. Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with – and field configurable to – commonly available sensing devices.

- F. Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
- G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct mounted heating coils, zone dampers, radiation etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- I. Input/Output points shall be the universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.
- J. System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.6 POWER SUPPLIES AND LINE FILTERING

- A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish overcurrent protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0 deg. C and 50 deg. C (32 deg F and 120 deg F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL STD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA approved.
- B. Power Line Filtering:
 - 1. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.8 AUXILIARY CONTROL DEVICES

- A. Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:
 - 1. Size dampers so that when wide open the pressure drop is a sufficient amount of its close off pressure drop to shift the characteristics curve to near linear.
 - 2. Control dampers shall be the parallel or opposed blade type.

- a. Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct airstreams toward each other.
 - b. Other modulating dampers shall be the opposed blade type.
 - c. Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals.
- 3. Damper frames shall be 13 gauge galvanized or stainless steel channel or 1/8 inch extruded aluminum with reinforced corner bracing.
- 4. Damper blades shall not exceed 6 inches in width or 48 inches in length. Blades are to be suitable for medium velocity performance (10 m/s [2000 ft/min]). Blades shall be not less than 14 gauge.
- 5. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
- 6. All blade edges and top, bottom and sides of the frame shall be provided with replaceable butyl rubber or neoprene seals. The blade seals shall provide for a maximum leakage rate of 5 cfm per ft² at 5 in. w.g. differential pressure. Provide air foil blades suitable for a wide-open face velocity of 1500 fpm.
- 7. Individual damper sections shall not be larger than 48 inches x 60 inches). Provide a minimum of one damper actuator per section.
- 8. Dampers shall have exposed linkages.
- B. Electric Damper/Valve Actuators:
 - 1. The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.
 - 2. For power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Arrange spring return, fail-safe at either the normally open or normally closed position in the event of power failure, control failure, fire or freeze-up protection as indicated on the Drawings.
 - 3. Proportional actuators shall accept a 0 to 10 VCD or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
 - 4. All 24 VAC/VDC actuators shall operate on Class 2 wiring.
 - 5. All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 Nm (60 in.-lb) torque capacity shall have a manual crank for this purpose.
 - 6. Actuators to be of sufficient size to operate device safely and within the required range.
- C. Control Valves:
 - 1. Control valves shall be two-way or three-way type for two-position or modulating service as shown. Provide valves of standard manufacturer.
 - 2. Provide position indicators.
 - 3. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - 1) Two-way: 150% of total system (pump) head.
 - 2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - 4. Valves shall be designed to modulate with up to 50 psi pressure differential across the valve.
 - 5. Water and Steam Valves:
 - a. Sizing Criteria:
 - 1) Select two way valves for liquids to have equal percentage characteristics. Select three-way valves for liquids to have linear characteristics.

2) Maximum 10 feet water pressure drop.

b. Valves 1/2 in. through 2 in. shall be bronze body or cast brass ANSI Class 250, with stainless steel trim spring-loaded, PTFE packing, quick opening for two position service. Two-way valves to have replaceable composition disc or stainless steel ball.

c. Valves 2-1/2 in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing, stainless steel trim.

D. Binary Temperature Devices:

1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F) set point range, 1 deg C (2 deg F) maximum differential and vented ABS plastic cover.
2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13 deg. C to 30 deg. C (55 deg F to 85 deg. F) setpoint range, 1 deg. C (2 deg. F) maximum differential, and vented ABS plastic cover.
3. Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by an 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only, but also manually resettable from the DDC system operator's workstation.

E. Temperature Sensors:

1. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor type. Room sensors shall be +/- 1% accuracy with setpoint adjustment.
2. Duct sensors shall be single point or averaging as shown, +/- 0.5% accuracy or +/- 0.25% as required by the application. Averaging sensors shall be a minimum of 5 ft in length per 10 ft² of duct cross section.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
4. Non-Public Spaces: Space sensors shall be equipped with set point adjustment, override digital switch, LCD display, and communication port. Use tamperproof screws to mount covers.
5. Public Spaces and Where Indicated on Drawings: Space sensors shall be a vandal-proof stainless steel plate, recess mounted with tamperproof screws. No setpoint adjustment.
6. Provide matched temperature sensors for differential temperature measurement.

F. Duct CO2 Sensor:

1. Measuring range shall be 0 to 2000 ppm.
2. Accuracy: +/- 50 ppm.
3. Calibration: Calibration free for eight years.

G. Humidity Sensors:

1. Room sensors shall have a sensing range of 20% to 80%. Duct sensors shall have a sensing range of 10% to 90%.
2. Duct sensors shall be provided with a sampling chamber and have +/- 3% accuracy.
3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall be suitable for ambient conditions of 32 deg. F to 170 deg. F.
4. Humidity sensor's drift shall not exceed 1% of full scale per year.

H. Flow Switches:

1. Flow-proving switches shall be either paddle or differential pressure type, as shown.

2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified.
3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snapacting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.

I. Relays:

1. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configurations, and coil voltage shall be suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable +/- 200% (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

J. Override Timers:

1. Override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer shall be suitable for flush mounting on control panel face and located on local control panels or where shown.

K. Current Transmitters:

1. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA twowireoutput. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and +/- 1% full-scale accuracy at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized
3. Unit shall be split-core type for clamp-on installation on existing wiring.

L. Current Transformers:

1. AC current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic materials.
2. Transformers shall be available in various current ratios and shall be selected for +/- 1% accuracy at 5 A full-scale output.
3. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

M. Voltage Transmitters:

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
2. Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with +/- 1% full-scale accuracy with 500 ohm maximum burden.
3. Transmitters shall be UL/CSA Recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.

N. Voltage Transformers:

1. AC voltage transformers shall be UL/CSA Recognized, 600 VAC rated, complete with built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4 deg. C to 55 deg. C (40 deg. F to 130 deg. F) and shall provide +/- .5% accuracy at 24 VAC and a 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic material.

O. Power Monitors:

1. Power monitors shall be the three-phase type furnished with three-phase disconnect/ shorting switch assembly, UL Listed voltage transformers, and UL Listed split-core current transformers.
 2. They shall provide a selectable rate pulse output for kWh reading and a 4 to 20 mA output for kW reading. They shall operate with 5 A current inputs with a maximum error of +/- 2% at 1.0 power factor or +/- 2.5% at 0.5 power factor.
- P. Current Switches:
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.
- Q. Water Pressure Transducers:
1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
 2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
 3. Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
 4. Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.
- R. Differential Pressure Type Switches (Air Or Water Service):
1. Switches shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as shown.
- S. Static Pressure Transmitters:
1. The sensors shall be a variable capacitance type, utilizing a stainless steel diaphragm and insulated electrode for position of the diaphragm. Provide isolation and bypass hand valves.
 2. The sensor shall produce a linear 4 to 20 mA with accuracies of 1% full scale in normal ambient temperature environments.
 3. Pressure ranges 0 to 0.1 w.g. through 0 to 25.0 in w.g.
 4. The transmitter shall be temperature compensated to account for any error over the entire temperature range of 40 degrees F to 100 degrees F to 95% RH. Overpressurization 10 inches w.g. or up to ten times range.
 5. Transmitter shall be equal to Setra Model C264.
- T. Fan Inlet Air Flow Measuring Stations:
1. Provide airflow traverse probes mounted in the fan inlets capable of continuously measuring the air handling capacity (air volume). Fan traverse probes shall be provided by this section and be factory-installed by the unit manufacturers.
 2. The fan inlet airflow traverse probes shall contain multiple total and static pressure sensors placed at concentric area centers internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.
 3. The fan inlet airflow traverse probes (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings, and shall be of aluminum construction with hard anodized finish.
 4. The fan inlet airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level within the system be amplified by its presence in the fan inlet bell. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with a minimum accuracy of 5% of actual flow over a fan operating range of 4 to 1 capacity turndown.

U. The airflow traverse probes shall be the EBTRON GTx108-F. Fan inlet probes shall be paired with an ultra-low differential pressure transmitter capable of accepting total and static pressure signals from the flow element and producing an electronic output linear and scaled for air volume 750 to 9000 fpm velocity, differential pressure. The transmitter shall include a multi-line display for use during configuration and calibration and to display output during normal operating mode. The transmitter will be available with multiple natural spans covering the range of 0.05" w.c. to 25.0" w.c. with an accuracy of 0.25%. Transmitters shall be factory calibrated to design parameters. The transmitter shall include an automatic zeroing circuit to eliminate thermal and mechanical drift effects of the transducer. Installed system accuracy calculated by the square root of the sum of the squares of flow element accuracy and transmitter accuracy at operating point shall not exceed +/- 3% of actual airflow. Duct Airflow Measuring Stations:

1. Provide airflow traverse probes mounted in the duct capable of continuously measuring the air handling capacity (air volume).
2. Units shall have a 14 gauge galvanized steel casing, aluminum honey comb (3 inch depth 3/8 inch cell) equalizer air straightener and turbulence eliminator.
3. Provide bullet nosed copper static pressure sensors representing equal measuring areas, copper total pressure sensors representing equal measuring areas, total and static pressure external points.
4. The duct airflow traverse probes shall not induce a pressure drop of 0.10 inches maximum static pressure at 2000 feet per minute air velocity. Probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with a minimum, AMCA certified accuracy of 2% of actual flow over an operating range of 4 to 1 capacity turndown.
5. The airflow traverse probes shall be the EBTRON Advantage 3 GTx116-P+.
6. Duct mounted probes and stations shall be paired with an ultra-low differential pressure transmitter capable of accepting total and static pressure signals from the flow element and producing an electronic output linear and scaled for air volume, velocity, and differential pressure. The transmitter shall include a multi-line display for use during configuration and calibration and to display output during normal operating mode. The transmitter will be available with multiple natural spans covering the range of 0.05" w.c. to 25.0" w.c. with an accuracy of 0.25%. Transmitters shall be factory calibrated to design parameters. The transmitter shall include an automatic zeroing circuit to eliminate thermal and mechanical drift effects of the transducer. Installed system accuracy calculated by the square root of the sum of the squares of flow element accuracy and transmitter accuracy at operating point shall not exceed +/- 3% of actual airflow. The airflow traverse probes shall be the EBTRON Advantage 3 GTx116-P+.

V. Outside Airflow Monitor:

1. Provide outside airflow monitor capable of direct measurement airflow through an outside air inlet.
2. The monitor shall contain an integral multi-line liquid crystal display for use during the configuration and calibration processes, and to display two measured processes (volume, velocity, temperature) during normal operation. All configuration, output scaling, calibration and controller tuning will be performed digitally in the on-board microprocessor via input pushbuttons.
3. The monitor shall measure inlet airflow with an accuracy of +5% of reading over a range of 150-2000 FPM, and not have its reading affected by the presence of directional or gusting wind.
4. Measured airflow shall be density corrected for ambient temperature variances, and atmospheric pressure due to site altitude.
5. The monitor shall interface with building automation system (BAS), accepting inputs for fan system start, economizer mode operation, and an external controller setpoint and provide flow deviation alarm outputs.
6. The monitor shall be constructed of materials that resist corrosion due to the presence of salt or chemicals in the air; all non-painted surfaces shall be constructed of stainless steel. The electronics enclosure shall be NEMA 1 NEMA 4; NEMA 4 with enclosure heating and insulation.

7. Install 20 gauge galvanized steel plate downstream of outside damper selected to provide pressure differential required for monitor. The monitor shall be EBTRON Advantage 3 GTx116-P+.

W. Local Control Panels:

1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance or field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide On/OFF power switch with overcurrent protection for control power sources to each local panel.

2.10 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Divisions 26, 27, and 28.
- B. All insulated wire to be copper conductors, UL labeled for 90 deg. C minimum service.

PART 3 - EXECUTION

3.1 SECTION INCLUDES

- A. Examination.
- B. Protection.
- C. Coordination.
- D. General Workmanship.
- E. Field Quality Control.
- F. Existing Equipment.
- G. Wiring.
- H. Communication Wiring.
- I. Fiber Optic Cable.
- J. Installation of Sensors.
- K. Flow Switch Installation.
- L. Actuators.
- M. Warning Labels.
- N. Identification of Hardware and Wiring.
- O. Controllers.
- P. Programming.
- Q. Control System Checkout and Testing.
- R. Control System Demonstration and Acceptance.
- S. Cleaning.
- T. Training.

3.2 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment requirements. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate-or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others-the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by – and at the expense of – the contractor.

3.3 PROTECTION

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.4 COORDINATION

- A. Site:
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist the working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- B. Submittals. Refer to the "Submittals" article in Part 1 of this specification for requirements.
- C. Test and Balance:
 - 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 - 3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 - 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
 - 1. All communication media and equipment shall be provided as specified in Part 2, "Communication" of this specification.

2. Each supplier of a controls product is responsible for the configuration, programming, startup and testing of that product to meet the sequences of operation described in this section.
3. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of the specification.
4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.5 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.6 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

3.7 EXISTING EQUIPMENT

- A. The contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators that are not required to be replaced as part of the project. Should the contractor find existing equipment that requires maintenance, the district is to be notified immediately. The contractor is responsible for any software upgrades or hardware expansion of the existing Niagara JACE system that is required for the new and replaced equipment.

3.8 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, Division 26, 27 and 28 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and Division 26 requirements.
- C. All DDC controllers shall have a dedicated 20 amp circuit. Where convenient more than one controller may be fed from the same 20 amp circuit.
- D. DDC controller outputs shall be wired normally closed for all equipment with status inputs. Outputs shall be wired normally open for all equipment without status inputs.
- E. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.)

1. All DDC controller input/output device wiring is to be run in metallic raceway with the following exceptions:
 - a. Suspended Ceilings – If such ceiling is a return or supply plenum the cable shall be plenum rated.
 - b. Chases.
 - c. Junction Boxes – Mounted within feet of the device. BX or similar may be used between device and junction box.
2. All devices utilizing modular type connectors will utilize factory fabricated cables or a combination of factory fabricated cables and terminal blocks. Field fabrication of modular plug terminated cables is not acceptable.
3. Any fittings, junction boxes, or raceway installed outside will be rated for outside use.
4. All treaded connectors are to be fitted with plastic bushings.
5. Any raceway, through, or junction box containing input/output wiring and/or communications cables shall be dedicated for such use, containing no conductors 40 volts or higher.
- F. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- G. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft.) intervals.
- H. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems. I. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- J. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- K. Maximum allowable voltage for control wiring shall be 120 V. If only high voltages are available, the contractor shall provide step-down transformers.
- L. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- M. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- N. Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirement's except as noted elsewhere.
- O. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- P. Use coded conductors throughout with conductors of different colors.
- Q. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- R. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).
- S. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- T. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.

- U. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- V. The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- W. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m (3 ft.) in length and shall be supported at each end. Flexible metal raceway less than ½ inc. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- X. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.9 COMMUNICATION WIRING

- A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- C. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.10 FIBER OPTIC CABLE SYSTEM

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.11 INSTALLATION OF SENSORS

- A. Install sensors in accordance with manufacturer's recommendations.
- B. Mount sensor rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. If to be mounted on existing walls, surface-mount temperature sensors in locations indicated on plans, and conceal control wiring in surface-mounted raceway or wiremold.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 ft of sensing element for each 1 ft² of coil area.
- G. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- I. Differential Air Static Pressure:
 - 1. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 4. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - 5. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.12 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch in accordance with manufacturer's instructions.

3.13 ACTUATORS

- A. Mount and link control damper actuators according to manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 deg. Open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic:
 - 1. Dampers: actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 deg. Available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
 - 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.14 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows:

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

3.15 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic nameplates.
- D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- E. Identify room sensors relating to terminal box or valves with nameplates.
- F. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- G. Identifiers shall match record documents.

3.16 CONTROLLERS

- A. Provide a separate controller for each RTU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controller shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
1. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points.

3.17 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Use the following naming convention:

AA.BBB.CCDDE where:

AA is used to designate the location of the point within the building, such as mechanical room, wing, or level or the building itself in a multi-building environment.

BBB is used to designate the mechanical system with which the point is associated (e.g., A01,

HTG, CLG, LTG).

CC represents the equipment or material referenced (e.g., SF for supply fan, RW for return water, EA for exhaust air, ZN for zone).

D or DD may be used for clarification or for identification if more than one CC exists (e.g., SF10, ZNB).

E represents the action or state of the equipment or medium (e.g., T for temperature, H for humidity, C for control, S for status, D for damper control, I for current).

C. Software Programming:

1. Provide programming for the system and adhere to district sequences of operation. All system programming necessary for the operation of the system, but not pertaining to the district Tridium system, also shall be provided by the contractor.
2. Occupancy Adjustments: When requested by the Owner within one year of the date of Substantial Completion, provide on-site assistance in reprogramming of the BAS to suit actual occupied conditions. Provide up to three visits to the site of this purpose.
3. Room numbers shall match existing/final room numbering plan upon the completion of the project. The room numbers indicated on the drawings are not necessarily the final room numbers and may be subject to change by the Owner.

3.18 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Start-up Testing: All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls and accessory equipment furnished under this specification.
 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer's recommendations.
 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper actions and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
 6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines.
 7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.19 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to provide the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 35% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall required further tuning by the Contractor.
 - b. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware of software to successfully complete all tests.

B. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if state as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.20 CLEANING

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

END OF SECTION 23 09 00

DIVISION 23 – MECHANICAL
SECTION 23 11 25
FACILITY GAS PIPING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.1	(2005; Addenda A 2007; Addenda B 2008) Household Cooking Gas Appliances
ANSI Z21.15/CSA 9.1	(2009) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves
ANSI Z21.24/CSA 6.10	(2006; Addenda 1 2009) Connectors for Gas Appliances
ANSI Z21.41/CSA 6.9	(2003; A 2005; B 2010; Errata 2007) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.69/CSA 6.16	(2009) Connectors for Movable Gas Appliances
ANSI Z21.78/CSA 6.20	(2005; Addenda A 2007; Addenda B 2008) Standard Specification for Combination Gas Controls for Gas Appliances

AMERICAN PETROLEUM INSTITUTE (API)

API 570	(2009, 3rd Ed) Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Spec 5CT	(2005; Errata 2006; Errata 2006) Specification for Casing and Tubing
API Spec 6D	(2008; Errata 2008; Errata 2008; Errata 2009; Addendum 2009; Errata 2010) Specification for Pipeline Valves
API Std 598	(2009) Valve Inspecting and Testing
API Std 607	(1998; R 2005; Errata 2008) Testing of Valves: Fire Test for Soft-Seated Quarter-Turn Valves

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ANSI/ASCE/SEI 25	(2006; R 2008) Earthquake-Activated Automatic Gas Shutoff Devices
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AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2004) Specification for Filler Metals for Brazing and Braze Welding
----------------	--

AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1
-------------	--

ASME INTERNATIONAL (ASME)

ASME A13.1	(2007) Scheme for the Identification of Piping Systems
------------	--

ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
--------------	---

ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe Flanges
-------------	--

ASME B16.33	(2002; R 2007) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, Sizes NPS 1/2 - NPS 2
-------------	---

ASME B31.9	(2008) Building Services Piping
------------	---------------------------------

ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
------------------	---

ASTM INTERNATIONAL (ASTM)

ASTM 01.01	(2010) Steel - Piping, Tubing, Fittings
------------	---

ASTM A 513	(2008a) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
------------	--

ASTM A 666	(2003) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
------------	---

ASTM F 2015	(2000; R 2006) Standard Specification for Lap Joint Flange Pipe End Applications
-------------	--

CSA STANDARDS (CSA)

CGA 3.11-M88	(1988; R 2009) Lever Operated Pressure Lubricated Plug Type Gas Shut-Off Valves
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CGA 3.16-M88	(1988; R 2009) Lever Operated Non-Lubricated Gas Shut-Off Valves
--------------	--

CGA 9.2-M88	(1988; R 2009) Manually Operated Shut-Off Valves for Gas Piping Systems
-------------	---

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-25	(2008) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2015) National Fuel Gas Code
NFPA 70	(2014) National Electrical Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1650	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 2nd Edition
-------------	--

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
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UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(2009) Flammable and Combustible Liquids and Gases Equipment Directory
----------------	--

1.2 SYSTEM DESCRIPTION

The gas piping system includes piping and appurtenances from point of connection with supply system, as indicated on site plans, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 017823 OPERATION AND MAINTENANCE DATA, in three separate packages.

A. Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, locations of system valves, gas line markers; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different).

B. Gas Facility System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer.

C. Gas Facility Equipment Maintenance

Include identification of valves, shut-offs, disconnects, and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide.

1.3 SUBMITTALS

Submit the following in accordance with Section [013000](#) ADMINISTRATIVE REQUIREMENTS:

Product Data

- Pipe and Fittings
- Gas equipment connectors
- Gas Piping System
- Pipe Coating Materials and application procedures
- Pressure regulators
- Risers
- Transition fittings
- Valves
- Valve box
- Warning and identification tape

Test Reports

- Testing
- Pressure Tests
- Test With Gas

Operation and Maintenance Data

- Gas facility system and equipment operation
- Gas facility system maintenance
- Gas facility equipment maintenance

1.4 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

A. Welding Qualifications

Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC SEC IX, and ASME B31.9. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9. Notify the Architect at least 24 hours in advance of tests, and perform at the work site if practicable.

B. Jointing Thermoplastic and Fiberglass Piping

Perform all jointing of piping using qualified joiners and qualified procedures in accordance with AGA XR0603. Furnish the Architect with a copy of qualified procedures and list of and identification symbols of qualified joiners. Submit manufacturer's installation instructions and manufacturer's visual joint appearance chart, including all PE pipe and fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe and fittings ends during transportation or storage to minimize dirt and moisture entry. Do not subject piping to abrasion or concentrated external loads. Discard PE pipe sections and fittings that have been damaged.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

2.2 GAS PIPING SYSTEM AND FITTINGS

A. Steel Pipe, Joints, and Fittings

All gas piping shall be Schedule 40 standard weight seamless black steel pipe complying with ANSI B36.10 and ASTM A53 or ASTM A106.

B. Steel Tubing, Joints and Fittings

Provide steel tubing conforming to ASTM 01.01, and ASTM A 513, with tubing joints made up with gas tubing fittings recommended by the tubing manufacturer.

C. Sealants for Steel Pipe Threaded Joints

Provide joint sealing compound as listed in UL Gas&Oil Dir, Class 20 or less. For taping, use tetrafluoroethylene tape conforming to UL Gas&Oil Dir.

D. Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags at a minimum of every 20 feet along all gas piping.

E. Flange Gaskets

Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, to be used for hydrocarbon service.

F. Pipe Threads

Provide pipe threads conforming to ASME B1.20.1.

G. Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

H. Gas Transition Fittings

Provide line size lever operated non-lubricated gas shut-off valves conforming to CGA 3.16-M88 at all equipment connections and for isolation of the gas system as shown on project drawings.

I. Insulating Pipe Joints

1. Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2. Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

3. Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts. Provide lap joint flange pipe ends conforming to ASTM F 2015.

J. Flexible Connectors

1. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to ANSI Z21.24/CSA 6.10 or ANSI Z21.41/CSA 6.9 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to ANSI Z21.69/CSA 6.16.
2. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide shutoff or service isolation valves as indicated in the drawings conforming to the following:

A. Valves 2 Inches and Smaller

Provide valves 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used. Provide manually operated household cooking gas appliance valves conforming to ANSI Z21.1 and ANSI Z21.15/CSA 9.1.

2.4 RISERS

Provide manufacturer's standard riser, use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide wall-mounted riser supports.

2.5 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58 and MSS SP-69.

A. Roof Supports: Erico Caddy Pyramid ST or MiFab C600 Series

2.6 REGULATORS

Provide a pressure regulator at the main service meter and as required at all equipment connections as to provide the manufacturer's required gas pressure at equipment connections.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Architect of any discrepancy or areas of conflict before performing the work.

3.2 EXCAVATION AND BACKFILLING

Provide required excavation, backfilling, and compaction as specified in Section 310000 EARTHWORK.

3.3 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, to the connections to each gas utilization device.

A. Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

B. Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

3.4 PROTECTIVE COVERING

A. Underground Metallic Pipe

Protect buried metallic piping from corrosion with protective coatings. When dissimilar metals are joined underground, use gastight insulating fittings.

B. Aboveground Metallic Piping Systems

1. Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed. Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances by power wire brushing and prime with ferrous metal primer. Finish all surfaces with two coats of yellow exterior oil of vinyl paint.

3.5 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used.

A. Metallic Piping Installation

Bury underground piping a minimum of 18 inches below grade. Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe in exterior locations or underground.

B. Metallic Tubing Installation

Install metallic tubing using gas tubing fittings approved by the tubing manufacturer. Make branch connections with tees. Prepare all tubing ends with tools designed for that purpose. Do not use aluminum alloy tubing in exterior locations or underground.

C. Piping Buried Under Buildings

Run underground piping installed beneath buildings in a steel pipe casing protected from corrosion with protective coatings. Extend casing at least 4 inches outside the building, and provide the pipe with spacers and end bushings to seal at both ends to prevent the entrance of water and/or the escape of gas. Extend a vent line from the annular space above grade outside to a point where gas will not be a hazard, and terminate in a rain/insect-resistant fitting.

D. Concealed Piping in Buildings

Do not use combinations of fittings (unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

1. Piping in Partitions

Locate concealed piping in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels.

2. Piping in Floors

Lay piping in solid floors except where embedment in concrete is indicated in channels suitably covered to permit access to the piping with minimum damage to the building.

Surround piping embedded in concrete by a minimum of 1-1/2 inches of concrete and do not allow physical contact with other metallic items such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quickset additives or cinder aggregate.

E. Aboveground Piping

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

F. Final Gas Connections

Unless otherwise specified, make final connections with rigid metallic pipe and fittings. Flexible connectors may be used for final connections to residential dryers only. Provide accessible gas shutoff valve, sediment catch, and coupling for each gas equipment item.

3.6 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

A. Threaded Metallic Joints

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

B. Welded Metallic Joints

Conform beveling, alignment, heat treatment, and inspection of welds to NFPA 54. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

C. Press Connections

Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Fully insert the tubing into the fitting and then mark at the shoulder of the fitting. Check the fitting alignment against the mark on the tubing to assure the tubing is fully inserted before the joint is pressed.

3.7 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor or roof, and cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in mechanical room floors above grade at least 4 inches above finish floor. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas. Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant.

3.8 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in Section [22 0000 PLUMBING, GENERAL PURPOSE](#).

3.9 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors.

3.10 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.11 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of .

3.12 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Architect.

3.13 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run, and manufacturer's instructions. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.14 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building which is electrically continuous and bonded to a grounding electrode as required by NFPA 70.

3.15 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

3.16 TESTING

Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure that it is gastight prior to putting into service. Prior to testing, blow out the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Architect. Do not use oxygen as a testing medium.

A. Pressure Tests

Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 0.1 pound. Isolate the source of pressure before the pressure tests are made.

B. Test With Gas

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of . If leakage is recorded, shut off the gas supply, repair the leak, and repeat the tests until all leaks have been stopped.

C. Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the proper safety precautions are followed.

D. Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.17 PIPE COLOR CODE MARKING

Provide color code marking of piping conforming to ASME A13.1. All piping to be painted yellow with black text "NATURAL GAS" and directional flow arrow.

END SECTION 23 11 25

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DIVISION 26 – ELECTRICAL
SECTION 26 00 00
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100 (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

IEEE C2 (2007; TIA 2007-1; TIA 2007-2; TIA 2007-3; TIA 2007-4; TIA 2007-5; Errata 2006-1; Errata 2007-2; Errata 2009-3) National Electrical Safety Code

IEEE C57.12.28 (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 11, EQUIPMENT, Divisions 22 and 23, PLUMBING and HEATING VENTILATING AND AIR CONDITIONING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections.

1.3 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

- c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 120/208volt, three phase, four wire, 60Hz. Final connections to the power distribution system shall be coordinated with the local utility company.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

A. Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

B. Product Data

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

B. Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

C. Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

D. Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 POSTED OPERATING INSTRUCTIONS

- A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
 - 1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - 2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - 3. Safety precautions.
 - 4. The procedure in the event of equipment failure.
 - 5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.
- B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.11 WARNING SIGNS

- A. Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.
 - 1. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.
 - 2. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.13 INSTRUCTION TO PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and any additional requirements specified in the technical sections for the environment where the equipment will operate.

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in architectural specifications.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

END SECTION 26 00 00

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DIVISION 26 - ELECTRICAL
SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL CABLES

PART 1 GENERAL

1.1 SUMMARY

A. The Section includes the following:

1. Building wire and cables rated 600 V and less.
2. Connectors, splices and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.2 REFERENCES

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1202 (2006; R 2012; CORR 1 2012) Flame-Propagation Testing of Wire and Cable

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-58-679 (2014) Control, Instrumentation and Thermocouple Extension Conductor Identification

ICEA T-30-520 (1986) Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 70,000 B.T.U./Hour

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 71/ICEA S-96-659 (1999) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy

NEMA WC 26 (2008) Binational Wire and Cable Packaging Standard

NEMA WC 57 (2014) Standard for Control, Thermocouple Extension, and Instrumentation Cables

NEMA WC 70 (2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658

NEMA WC 74/ICEA S-93-639(2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

- UL 1685 (2015) UL Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
- UL 2556 (2015) UL Standard for Safety Wire and Cable Test Methods
- UL 44 (2014; Reprint Feb 2015) Thermoset-Insulated Wires and Cables
- UL 83 (2014) Thermoplastic-Insulated Wires and Cables

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.4 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors only: Comply with NEMA WC 70.
- B. Conductor Insulation: THHN/THWN for wires #2 and less; and XHHW-2 for wires outside of building envelope and larger than #2.
- C. Armor Ground Type MC Cable: Comply with UL 1569 and UL 83.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type and class for application and service indicated.
 - 1. Spring Wire Connectors: Corrosion resistant, insulated steel, 105°C.
 - 2. Connectors and Lugs shall be circumferential compression type.
- B. MC Cable connectors shall comply with UL 514B. MC Cable fitting shall be listed for use with Interlocked Armor Ground MC Cable Type "MCI-A". MC Cable fitting shall also be listed as being suitable for grounding for in circuits over and under 250 volts.

2.3 MC CABLE

- A. Cable Assembly: Type THHN insulated copper conductors and an insulated grounding conductor. Minimum size shall be #12 AWG for lighting and power circuits.
 - 1. Cable Jacket color shall be:
 - a. Black Coated for 120V Normal Power.
 - b. Brown Coated for 277V Normal power.

- B. Metal-Clad Sheath/Armor Assembly: The interlocking metal tape armor shall be aluminum and shall be listed as being suitable for grounding.

2.4 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper, Stranded for all AWG sizes.
- B. Branch Circuits: Copper, Stranded for all AWG sizes.
- C. Motors and equipment connections subject to vibration: Copper. No. 12 AWG and larger, stranded conductor, single conductor.
- D. MC Cable may only be used at the contractor's option for lighting branch circuits between fixtures and junction boxes. Install per manufacturer's instructions.
 - 1. DO NOT USE for home runs, receptacles, above in-accessible ceilings, exposed in unfinished spaces, circuits crossing smoke or fire barriers, in exterior locations, or where exposed to view.
 - 2. Support MC cables above accessible ceilings from the building structure. DO NOT SUPPORT from cable tray, ductwork, equipment, or ceiling support wires.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Single conductors in raceway.
- B. Exposed Feeders: Single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Single conductors in raceway.
- E. Exposed Branch Circuits: Single conductors in raceway.
- F. Lighting Branch Circuits above accessible ceilings:
 - 1. Single conductors in raceway.
 - 2. Metal-clad cable, Type MC.
- G. Branch Circuits Concealed in walls, Concrete, below Slabs-on-Grade, and Underground: Single conductors in raceway.
- H. Class 1 and Class 2 Control Circuits: Single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings and floors, unless otherwise indicated. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed conduits parallel and perpendicular to surfaces of exposed structure members, and follow surface contours where possible.
- E. Support cables according to Section 260529 – Hangers and Supports for Electrical Systems.
- F. Identify and color-code conductors and cables according to Section 260553 – Identification for Electrical Systems.

3.4 ELECTRICAL CONTINUITY OF METAL RACEWAYS, CABLE ARMOR AND ENCLOSURES

- A. General: Metal raceways, cable armor and other metal enclosures for conductors shall be metalically joined together into a continuous electric conductor and shall be connected to all boxes, fittings, and cabinets or enclosures so as to provide an effective ground fault current path per Section 250.4 of the NEC.

3.5 VOLTAGE DROP REQUIREMENTS

- A. Feeders: Feeders shall be sized for maximum voltage drop of 2%.
- B. Branch circuits:
 - 1. Do not use wire smaller than No. 12 AWG (unless otherwise noted) for branch circuit wiring, including motor circuits. All 20 amp, 120 volt and 277 volt branch circuit homeruns (to panelboard) serving receptacles, equipment and lighting shall be No. 10 AWG minimum to first outlet or light fixture.
 - 2. Size 120V branch circuits for length of run on the following basis:
 - a. 0 to 50 ft. run from panelboard to first outlet: No. 12 AWG minimum.
 - b. 51 to 85 ft. run from panelboard; No. 10 AWG minimum.
 - c. 86 to 135 ft. run from panelboard; No. 8 AWG minimum to first outlet.
 - d. 136 to 225 ft. run: wiring shall be No. 6 AWG minimum to first outlet.
 - e. For other branch circuits, size conductors so that voltage drop does not exceed 3%.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- B. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

- C. Cut sleeves to length for mounting flush with both wall surfaces.
- D. Extend sleeves installed in floors 2 inches above finished floor level.
- E. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors to cable penetrations. Install sleeves and seal with firestop materials according to Section 078400 – “Firestopping”.
- F. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- G. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals.
- H. Underground Exterior-Wall Penetrations: Install cast-iron “wall pipes” for sleeves.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assemble according to Section 07 84 00 – Firestopping.

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
 - 2. Perform the following visual and mechanical inspection and electrical tests:
 - a. Compare cable data and wire sizes with drawings and specifications.
 - b. Expect cables for damage and correct connections per one line diagrams.
 - c. Verify tightness of connections, and test connections for high resistance.
 - d. Inspect for correct phase arrangements and jacket insulation.
- B. Test Reports: Record test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Remove and replace malfunctioning units and retest as specified above.

END SECTION 26 05 19

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DIVISION 26 - ELECTRICAL
SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding system and equipment, plus the following special applications: Underground distribution grounding.

1.2 REFERENCES

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM B3 (2013) Standard Specification for Soft or Annealed Copper Wire

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81 (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467 (2013) Grounding and Bonding Equipment

1.3 QUALITY ASSURANCE

- A. Electrical Components, Listed and labeled as defined in NFPA 70, Article 100.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V.
- B. Bare Copper Conductors:
1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.

- C. Bonding Conductor: #4 or #6 AWG, stranded.
- D. Bonding Jumper: Copper tape, braided conductors with copper ferrules; 1-5/8" wide x 1/16" thick.
- E. Grounding Bus: Rectangular bars of annealed copper, 1/4" x 2" x 12", unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Bolted Connectors:
 - 1. Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 2. Pipe Connectors: Clamp type, sized for pipe.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conduits.
- C. Compression Connectors: Irreversible type meeting IEEE Standard 837-2002, UL Listed.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet in diameter.
- B. Ground plates shall be A#233M Copper plate. Provide ground plates where ground rods cannot be installed.
- C. Grounding Test Wells:
 - 1. Well Pipe: 8" x 24" long pipe with belled end.
 - 2. Well Cover: Cast iron, bolted, with "GROUND" embossed on traffic rated cover.

PART 3 EXECUTION

3.1 APPLICATIONS

- A. Conductors: All conductors to be stranded conductors unless otherwise indicated.
- B. Underground: Install bare copper conductors, #3/0 AWG, minimum 30" below grade.
- C. Isolated Ground: Green insulation with yellow stripe.
- D. Grounding Bus: Install in electrical rooms, in rooms housing service equipment.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors and as otherwise indicated.
 - 3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Isolated Grounding Receptacles Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding conductor terminal of the applicable derived system or service.

- C. Signal and Communication Equipment: For alarm, voice and data, and other communication equipment, see Section 270526

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment: 3 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Project Manager promptly and include recommendations to reduce ground resistance.

END SECTION 26 05 26

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DIVISION 26 - ELECTRICAL
SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes Hangers and supports for electrical equipment and systems.

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code (NEC) 2014

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Metallic Coating: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 2. Channel Dimensions: Selected for applicable load criteria.
 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 4. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 5. Rated Strength: Selected to suit applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for type and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars: black and galvanized.
- F. Mounting, Anchoring and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Power-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used. Approval from structural engineer shall be obtained prior to the use of power-actuated fasteners.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.
- C. ASTM A 36A/36M steel plates, shapes, and bars; black and galvanized.

PART 3 EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT and RMC as required by NFPA 70. Minimum rod size will be ¼ inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits. Secure raceways and cables to these supports with

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two-bolt conduit clamps for conduits 1 ¼ inch and larger, single-bolt conduit clamps for conduits 1 inch and smaller.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts and Beam clamps (MSS Type 19, 21, 23, 25 or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 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.
- B. Lighting fixtures shall be supported to building structure independent of ceiling support system. Fixture support wires shall be same size and material used to support ceiling system. Provide adequate support so that fixture cannot be rotated or displaced. Contractor shall submit proposed method of fixture support to Engineer for review prior to installation.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 PAINTING

- A. Touchup: Comply with requirements in Section 09 90 00 – "Paints and Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END SECTION 26 05 29

DIVISION 26 - ELECTRICAL
SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Section 26 05 29 – Hangers and Supports for Electrical Systems.
 - 2. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems.

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code (NEC) 2014

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel or aluminum.
- E. LFMC: Flexible steel conduit with PVC Jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed. Fittings for EMT: Steel Insulated Throat, set-screw or gland compression type.
- G. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Metal Floor Boxes: Fully adjustable, rectangular equal to Wiremold 880 Omnibox series
 - 1. Cast Metal for on grade applications (2 7/16" deep).
 - 2. Stamped Steel for above grade applications (3 1/2" deep).
 - 3. Provide brushed aluminum finish flanges and cover to match floor surface type.
 - 4. Provide number of gangs as indicated on drawings.

2.4 TRENCHDUCT IN CONFERENCE ROOMS

- A. Manufacturer shall be Wiremold.
- B. Body material shall be constructed of 16 gauge galvanized steel.
- C. Fully adjustable before concrete pour.
- D. Trenchduct shall be of the following dimensions:
 - 1. Width: 18"
 - 2. Depth: 3"
 - 3. Length: Refer to drawings.
- E. Provide adjustable partition to separate power wiring from communication and A/V components.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Concealed Conduit, Aboveground: EMT.
 - 3. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

4. Underground Conduit: RNC, Type EPC-40-PVC.
 5. Connection to Vibrating Equipment: LFMC.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Physical Damage: Rigid steel conduit below switch height and EMT above switch height, except in equipment rooms, closets, chases and similar locations.
 3. Concealed in Ceiling and Interior Walls and Partitions: EMT (See Section 26 05 19 for acceptable use of MC cable).
 4. Connection to Vibrating Equipment: FMC, except use LFMC in damp or wet locations.
 5. Connections to lighting fixtures in accessible ceilings: FMC –Maximum 72" in length.
 6. Damp or Wet Locations: Rigid steel conduit between grade and 96" above grade; EMT with rain tight compression fittings above 96".
 7. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R in damp or wet locations.
- C. Minimum Raceway Size: Minimum conduit size shall be ¾-inch trade size except for switch legs and control circuits may be ½ inch.
- D. Homerun conduit size shall be 1" trade size minimum.
- E. Minimum FMC size shall be ½", except that lighting fixture connections may be 3/8".
- F. Raceway Fittings: Compatible with raceways and suitable for use and location. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Specification Section 26 05 29 – Hangers and Supports for Electrical Systems.
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit.
- G. Conceal conduit within finished walls, ceilings and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 1. Run conduit larger than 1 inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Change from PVC to EMT or rigid steel conduit before rising above the floor.
- I. Where RNC conduit is installed, all 90 degree bends for conduit 1-1/2" and larger shall be made with a black mastic coated rigid steel conduit elbow.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm or cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install each expansion-joint fitting with position, mounting and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, maximum of 36 inches of flexible conduit equipment subject to vibration, noise transmission or movement; and for transformers and motors. Use LFMC in damp or wet locations
- O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- P. Set metal floor boxes level and flush with finished floor surface.

3.3 OUTLET BOX LOCATIONS

- A. Locate flush mounted wall boxes in corner or 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 shall 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. Conflict with millwork, tack boards, etc. Contractor shall review architectural elevations and millwork drawings before roughing-in boxes and conduit. Any conflicts shall be raised to the project manager.

- D. Minor modification in the location of outlets and equipment is considered incidental up to a distance of 10 feet with no additional compensation, providing necessary instructions are given prior to roughing in of outlet.
- E. Metallic electrical outlet boxes may be installed in vertical fire resistive assemblies classified as fire/smoke and smoke partitions without affecting the fire classification, provided such openings do not exceed 16 square inches and they are located per applicable U.L. assembly. All clearances between such outlet boxes and the gypsum board must be completely filled with joint compound or other approved materials. The wall must be built around outlets of a larger size so as to not interfere with the integrity of the wall rating. The aggregate surface area of the boxes shall not exceed 100 square inches per 100 square feet. Boxes located on opposite sides of walls or partitions shall be separated by a horizontal distance of 24 inches. The metallic outlet or switch boxes shall be securely fastened to the studs and the openings in the wallboard facing shall be cut so that the clearance between the box and the wallboard does not exceed 1/8 inch.
- F. In general, do not install boxes back to back or through wall. Offset outlet boxes on opposite sides of wall a minimum of 12 inches or on opposite sides of stud in partition walls. Where back to back boxes cannot be avoided, provide gypsum board between boxes.
- G. Where more than two switches or devices are located at one point use ganged boxes and covers, unless devices do not allow for ganging. Contractor to verify suitability of devices for gang mounting. Provide permanently installed barrier (U.L. Listed) between adjacent switches where required per N.E.C. Article 404.8 or Article 700.9.
- H. Exposed outlet and junction boxes
 1. Cast boxes up to 4'-0" above floor for exposed conduit runs.
 2. Pressed steel boxes acceptable above 4'-0".

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 – Firestopping.

3.5 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END SECTION 26 05 33

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DIVISION 26 - ELECTRICAL
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceways and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with UL 969 for adhesive labels

1.3 COORDINATION

- A. Coordinate identification names, abbreviations, colors and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and in the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout the Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 FLOOR MARKING TAPE

- A. 2" wide, 5 Mil pressure sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES".

2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Paint materials and application requirements are specified in Section 099100 – “Paint and Coatings”.
- B. Fasteners for Labels and Signs: Self-tapping stainless steel screws, except contact type permanent commercial grade adhesive providing a permanent bond shall be used where screwed cannot or should not penetrate substrate.
- C. Two-sided tape and dynamo tape adhesives are not acceptable.

PART 3 EXECUTION

3.1 APPLICATION

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with paint as noted below.
 - 1. All junction boxes for the shall be painted as follows:
 - a. Telecommunications Systems - Blue
 - b. Fire Alarm System – Red
- B. Power-Circuit Conductor Identification: For primary and secondary conductors in pull boxes, junction boxes and manholes/handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.
- D. At each junction box, the covers on junction boxes and pull boxes in areas that are not to be painted shall be marked with "Indelible Markers" to indicate the circuit number(s) of conductors in the box. In areas where exposed conduit and junction boxes are to be painted, indicate circuit number(s) of conductors in the box on the inside cover of the box.
- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.
- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and communications cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Apply to exterior of door, cover, or other access.
 - 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

- a. Power transfer switches
 - b. Controls with external control power connections.
 - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- H. Instruction Signs:
- 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 - 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer load shedding.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
- 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with ½-inch high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high and greater.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealing electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Emergency system boxes and enclosures
 - f. Disconnect switches.
 - g. Enclosed circuit breakers.
 - h. Motor starters and VFDs.
 - i. Push-button stations.
 - j. Power transfer equipment.
 - k. Contactors.
 - l. Remote-controlled switches, dimmer modules, and control devices.
 - m. Power-generating units.
 - n. Fire-alarm control panel and annunciators.
 - o. Lighting Control Panels
- J. Engraved laminate signs shall have lettering as follows:
- 1. Fire Alarm System – Red field with white lettering

2. Normal Power - White lettering in a black field.

- K. Where the electrical system is comprised of normal power and emergency power, the equipment connected to the normal power system shall have engraved laminate signs with white lettering in a black field. Equipment connected to the emergency power system shall have engraved laminate signs with black lettering in a yellow field.
- L. Panelboard identification shall indicate building name, panelboard designation, voltage and where fed from, i.e.:

LEWIS LEMON ELEMENTARY PANEL LLES-LA 120/208V, 3 PHASE, 4W FED FROM LLES-SBLA
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- M. Panelboards located in storage rooms shall have floor space per NEC-110 permanently marked and shall be identified as "Electrical Access - Not For Storage."

3.2 COVER PLATES

- A. All wiring device cover plates shall have panel name and circuit number serving device clearly marked (e.g. "MMS-LA") on the back of each faceplate with indelible marker.

3.3 PANELBOARD CIRCUIT DIRECTORIES

- A. Install in each panelboard a typewritten directory accurately indicating rooms and equipment being served. Verify actual room names and numbers to be used. Also, provide a copy of typewritten panelboard directories in Owner's close-out manuals.

3.4 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied or, for sizes larger than No. 12 AWG if authorities having jurisdiction permit, field applied.
 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.

- d. Neutral: White.
 - e. Ground: Green.
 - f. Isolated Ground: Green/Yellow Tracer.
3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- H. Painted Identification: Prepare surface and apply paint according to Section 099100 – “Painting”.

END SECTION 26 05 53

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes computer-based, arc flash, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study. A system study will be completed on that portion of the electrical distribution system affected by this project, this includes all equipment from the Utility down to each of the two new panelboards. Arc Flash Labels shall be generated and applied to the Main Breaker Section of the Fused Switchboard, Distribution Sections of the Switchboard, and each Panelboard. The short circuit and coordination study shall also include the equipment listed above.

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code (NEC) (2014)
- B. NFPA 70E – Standard for Electrical Safety in the Workplace (2015)

1.3 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
 - 1. EasyPower LLC.
 - 2. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Distribution panelboard.
 - 3. Branch circuit panelboard
- B. Study electrical distribution system from normal utility power sources throughout electrical distribution system for project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions. Initial fault calculation shall be completed and submitted prior to electrical equipment submittals.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with and IEEE 242.
 - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 2. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report: Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the

primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FAULT STUDY

- A. An arc flash hazard analysis on the electrical distribution system shall be performed as per NFPA 70E regulations and NEC 110.16. The analysis includes the site data collection and verification of the electrical distribution system attributes that affect the incident energy available. Vinyl UV resistant arc flash labels would be installed on all applicable electrical enclosures. The labels shall clearly indicate the electrical hazards present in the electrical panels. The hazard labels list detailed information such as: The required safe work distance for each task, The Arc Flash hazard in cal/cm², The level and type of Personal Protective Equipment that must be worn when working in the enclosure live and Identification of the enclosure with a specific name.

END SECTION 26 05 73

DIVISION 26 - ELECTRICAL
SECTION 26 09 23
NETWORK LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.
 - 2. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed)
 - 3. All system devices shall be networked together enabling digital communication and shall be individually addressable.
 - 4. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.
 - 5. The system architecture shall facilitate remote operation via a computer connection.
 - 6. The system shall not require any centrally hardwired switching equipment.
 - 7. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.
- B. Related Sections include the following:
 - 1. Division 26 Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches

1.2 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code (NEC) 2014
- B. ICC – International Energy Conservation Code (IECC) 2015

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, and marked for intended use.

1.4 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.
- B. Coordinate lighting control components to form an integrated interconnection of compatible components.
- C. Coordinate lighting controls with BAS (if necessary) either through IP based intercommunication of system or hardwired auxiliary relay outputs. Timeclock function for exterior lighting shall be through the BAS.
- D. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.5 WARRANTY

- A. All devices in lighting control system shall have a 5 year warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following: Sensor Switch, Inc.

2.2 SYSTEM REQUIREMENTS

- A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
- B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
- C. System must interface directly with intelligent LED luminaires such that only CAT-5e cabling is required to interconnect luminaires with control components such as sensors and switches (see *Networked LED Luminaire* section)
- D. Intelligent lighting control devices shall communicate digitally, require <4 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
- E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
- F. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
- G. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- H. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
- I. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, or from the network backbone. Standalone "bus power supplies" shall not be required in all cases.
- J. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

- K. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
- L. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
- M. System shall be capable of wirelessly connecting a lighting zone to a WiFi (802.11n) wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.
- N. WiFi enabled devices shall be able to detect when WiFi network is down and revert to a user directed default state.
- O. WiFi-enabled devices shall be capable of current monitoring
- P. WiFi-enabled devices shall utilize WPA2 AES encryption
- Q. WiFi-enabled devices shall be able to connect to 802.11b/g/n WiFi networks
- R. WiFi-enabled devices shall have at least one local RJ-45 port for communicating with nonWiFi-enabled system devices
- S. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control profiles.
- T. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
- U. Devices located in different lighting zones shall be able to communicate occupancy, photocell, and switch information via either the wired or WiFi backbone.
- V. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.
 - 1. Auto-On / Auto-Off (via occupancy sensors)
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
 - 2. Manual-On / Auto-Off (also called Semi-Automatic)
 - a. Pushing a switch will turn lights on.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - 3. Manual-On to Auto-On/Auto-Off
 - a. Pushing a switch will turn lights on.
 - b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events
 - 4. Auto-to-Override On
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.

- b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events
- 5. Manual-to-Override On
 - a. Pushing a switch will turn lights on.
 - b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
- 6. Sequence can be reset via scheduled (ex. daily each morning) events
 - a. Auto On / Predictive Off
 - b. Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - c. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - d. If switch is pressed, lights turn off and a short "exit timer" begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
- 7. Multi-Level Operation (multiple lighting levels per manual button press)
 - a. Operating mode designed specifically for bi-level applications
 - b. Enables the user to cycle through the up to four potential on/off lighting states using only a single button.
 - c. Eliminates user confusion as to which of two buttons controls which load
 - d. Three different transition sequences are available in order to comply with energy codes or user preference)
 - e. Mode available as a setting on all nLight devices that have single manual on/off switch (ex. nWSX, nPODM, nPODM-DX).
 - f. Depending on the sequence selected, every button push steps through relays states according to below table
 - g. In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to "step" in a sequence that achieves bi-level operation is present.

	Alternating Sequence		Full On Sequence		3 Step On Sequence	
Sequence State #	Relay 1	Relay 2	Relay 1	Relay 2	Relay 1	Relay 2
1	On	Off	On	Off	On	Off
2	Off	On	-	-	Off	On
3	-	-	On	On	On	On
4*	Off	Off	Off	Off	Off	Off

(*step only present for devices without separate off button)

W. A taskbar style desktop application shall be available for personal lighting control.

- X. An application that runs on “smart” handheld devices (such as an Apple® iPhone®) shall be available for personal lighting control.
- Y. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.
- Z. Control software shall enable integration with a BMS via BACnet IP.
- AA. System shall provide the option of having pre-terminated plenum rated CAT-5e cabling supplied with hardware.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

- A. Control Module (Gateway)
 1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet.
 2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
 3. Control device shall have three RJ-45 ports for connection to other backbone devices (bridges) or directly to lighting control devices.
 4. Device shall automatically detect all devices downstream of it.
 5. Device shall have a standard and astronomical internal time clock.
 6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
 7. Device shall have a USB port
 8. Each control gateway device shall be capable of linking 1500 devices to the management software.
 9. Device shall be capable of using a dedicated or DHCP assigned IP address.
 10. Network Control Gateway device shall be the following Sensor Switch model Series:
nGWY2
- B. Networked System Occupancy Sensors
 1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
 2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
 3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
 4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
 5. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

6. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.
7. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
8. Sensors shall be available in multiple lens options which are customized for specific applications.
9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
14. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
17. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.
18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls
20. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:
 - nWSD or nWSX** (PIR, 1 Relay)
 - nWSD PDT or nWSX PDT** (Dual Tech, 1 Relay)
 - nWSD NL** (PIR w/ Night Light, 1 Relay)
 - nWSD PDT NL** (Dual Tech w/ Night Light, 1 Relay)
 - nWSX NL LV** (PIR w/ Night Light, No Relay)
 - nWSD PDT NL LV** (Dual Tech w/ Night Light, No Relay)
 - nWSD LV or nWSX LV** (PIR, No Relay, Raise/Lower Dim Ctrl)
 - nWSD PDT LV or nWSX PDT LV** (Dual Tech w/ Night Light, No Relay, Raise/Lower Dim Ctrl)
21. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
22. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection
23. Embedded sensors shall have an optional photocell

24. Embedded sensors shall be the following Sensor Switch model number:

nES 7 (PIR, No Relay)
nES 7 ADCX (PIR w/ Photocell, No Relay)
nES PDT 7 (Dual Technology, No Relay)
nES PDT 7 ADCX (Dual Technology w/ Photocell, No Relay)

25. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
26. Fixture mount sensors shall be capable of powering themselves via a line power feed.
27. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
28. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).
29. Sensors shall be the following Sensor Switch model numbers, with device options as specified:

Model # Series	Occupancy Poles	# of Relays	Lens Type	Detection Technology
nCM(B) 9	1	-	Standard	PIR
nCM(B) 9 2P	2	-	Standard	PIR
nCMR(B) 9	1	1	Standard	PIR
nCMR(B) 9 2P	2	2	Standard	PIR
nCM(B) PDT 9	1	-	Standard	Dual
nCM(B) PDT 9 2P	2	-	Standard	Dual
nCMR(B) PDT 9	1	1	Standard	Dual
nCMR(B) PDT 9 2P	2	2	Standard	Dual
nCM(B) 10	1	-	Extended	PIR
nCM(B) 10 2P	2	-	Extended	PIR
nCMR(B) 10	1	1	Extended	PIR
nCMR(B) 10 2P	2	2	Extended	PIR
nCM(B) PDT 10	1	-	Extended	Dual
nCM(B) PDT 10 2P	2	-	Extended	Dual
nCMR(B) PDT 10	1	1	Extended	Dual
nCMR(B) PDT 10 2P	2	2	Extended	Dual
nWV 16	1	-	Wide View	PIR
nWV PDT 16	1	-	Wide View	Dual
nHW13	1	-	Hallway	PIR
nCM(B) 6	1	-	High Bay	PIR
nCMR(B) 6	1	1	High Bay	PIR
nCMR(B) 6 2P	2	2	High Bay	PIR
nCMR(B) 6 480	1	2	High Bay	PIR

Note: Recessed mount versions of the above ceiling(fixture) mount versions also shall be available (e.g. nCMR(B) 9 => nRMR 9)

30. System shall have WiFi enabled fixture mountable sensors available.
31. Embedded sensors shall have an optional photocell and 0-10 VDC dimming output
32. WiFi enable sensors shall be one of the Sensor Switch model numbers:

nCMRB 6 WIFI (PIR, w/ Relay)
nCMRB 10 WIFI (PIR, w/ Relay)
nCMRB 50 WIFI (PIR, w/ Relay)
nCMRB 9 WIFI (PIR, w/ Relay)

C. Networked System Daylight (Photocell and or Dimming) Sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of class 2 current (typically 40 or more ballasts).
5. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.
8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load. Relays shall be dry contacts.
9. Sensor shall be the following Sensor Switch model numbers, with device options as specified:

nCM(B) PC (on/off))

nCM(B) ADC (dimming)

nCM(B) PC ADC (on/off, 0-10 VDC dimming)

nCMR(B) PC (on/off, single relay)

nCMR(B) PC ADC (on/off, 0-10 VDC dimming, single relay)

Note: Recessed mount versions of the above ceiling(fixture) mount versions also shall be available (e.g. nCMR(B) PC => nRMR PC)

10. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
11. Embedded sensors shall be the following Sensor Switch model number:

nES ADCX (Dimming Photocell)

D. Networked System Power (Relay) Packs

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
7. Power Packs and Power Supplies shall be available that are WiFi enabled.
8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.
9. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.
11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
12. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
13. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
14. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.
15. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.
16. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
17. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
18. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
19. Power (Relay) Packs and Supplies shall be the following Sensor Switch model Series:
 - nPP16** (Power Pack w/ 16A relay)
 - nPP16 WIFI** (Power Pack w/ 16A relay, WIFI enabled)
 - nEPP5 D** (Power Pack w/ 5A relay and 0-10VDC dimming output)
 - nSP16** (Secondary Pack w/ 16A relay)

nSP5 2P (Secondary Pack w/ two 5A relays)

nSP5 D (Secondary Pack w/ 5A relay and 0-10VDC dimming output)

nPP16 ER (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)

nSP5 D ER (UL924 Listed Secondary Pack w/ 5A relay and 0-10VDC dimming output for switching emergency power circuits)

nSP5 PCD 2W (Secondary Pack w/ 5A relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)

nSP5 PCD 3W (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output)

nSP5 PCD MLV (Secondary Pack w/ 5A relay and magnetic low voltage dimming output)

nSP5 PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output)

nSP5 480 (Secondary Pack w/ 5A relay for switching 208/240/480 VAC loads)

nSP5 2P LVR (Louver/Damper Control Pack)

nSHADE (Pulse On/Off Control Pack)

nPS 80 (Auxiliary Bus Power Supply)

nPS 80 WIFI (Auxiliary Bus Power Supply, WiFi enabled)

nAR 40 (Low voltage auxiliary relay pack)

E. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection
8. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:
 - nPANEL 4** (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
 - nPANEL 2 480** (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)

F. Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
5. Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
7. Specific I/O devices shall sense state of low voltage outdoor photocells
8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
9. Specific I/O devices shall sense .
10. Auxiliary Input/Output Devices shall be the following Sensor Switch model numbers:
 - nIO D** (I/O device with 0-10 dimming output)
 - nIO 1S** or **nIO RLX** (I/O device with contact closure or 0-10VDC dimming input)
 - nIO NLI** (Input device for detecting state of low voltage outdoor photocell; sold in **nIO PC KIT** only)
 - nIO X** (Interface device for communicating with RS-232 enabled AV Touch Screens

G. Networked LED Luminaires

1. Networked LED luminaire shall have a mechanically integrated control device
2. Networked LED luminaire shall have two RJ-45 ports
3. Networked LED luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)
4. Networked LED luminaire shall provide low voltage power to other networked control devices
5. System shall be able to turn on/off LED luminaire without using a relay
6. System shall be able to maintain constant lumen output over the specified life of the LED luminarie (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).
7. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hrs).
8. LED Luminaires shall be the following Lithonia model families:

RTLED

TLED

VLED

ACLED

AL LED

WLED

STLED

MINO

H. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Devices shall be available with zero or one integrated Class 1 switching relay.

3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. All sensors shall have two RJ-45 ports.
5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
7. Devices with dimming control outputs can control 0-10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).
8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.
9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
10. Devices with mechanical push-buttons shall be made available with custom button labeling
11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
12. Wall switches & dimmers shall be the following Sensor Switch model numbers, with device options as specified:
 - nPOD** (single on/off, capacitive touch, audible user feedback)
 - nPOD 2P** (dual on/off, capacitive touch, audible user feedback)
 - nPODR** (single on/off, one relay, capacitive touch, audible user feedback)
 - nPODM** (single on/off, push-buttons, LED user feedback)
 - nPODM 2P** (dual on/off, push-buttons, LED user feedback)
 - nPODM DX** (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
 - nPODM 2P DX** (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
 - nPODM 4P** (quad on/off, push-buttons, LED user feedback)
 - nPODM 4P DX** (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

I. Networked System Graphic Wall Station

1. Device shall have a 3.5" full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switches.
2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
3. Device shall enable user supplied .jpg screen saver image to be uploaded.
4. Device shall surface mount to single-gang switch box
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Device shall have two RJ-45 ports for communication
7. Device shall be the following Sensor Switch model number:
 - nPOD GFX**

J. Networked System Scene Controllers

1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.

2. Device shall recess into single-gang switch box and fit a standard GFI opening.
3. Devices shall provide LED user feedback.
4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
5. All sensors shall have two RJ-45 ports.
6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
7. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
8. Device shall have LEDs indicating current selection.
9. Scene Selector device shall be the following Sensor Switch model number:
nPODM 2S (2 Scene, push-button)
nPODM 4S (4 Scene, push-button)
nPODM 4S DX (4 Scene, push-button, On/Off/Raise/Lower)
nPODM 4L DX (4 Adjustable Presets, push-button, On/Off/Raise/Lower)

K. Communication Bridges

1. Device shall surface mount to a standard 4" x 4" square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
6. Communication Bridge devices shall be the following Sensor Switch model numbers:
nBRG 8 (8 Ports)

2.4 LIGHTING CONTROL PROFILES

- A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.
- B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.
- C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.
- D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.
- E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

- F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.
- G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
- H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
- I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.
- J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5 MANAGEMENT SOFTWARE

- A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software
- B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).
- C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
- D. A printable network inventory report shall be available via the software.
- E. A printable report detailing all system profiles shall be available via the software.
- F. Software shall require all users to login with a User Name and Password.
- G. Software shall provide at least three permission levels for users.
- H. All sensitive stored information and privileged communication by the software shall be encrypted.
- I. All device firmware and system software updates must be available for automatic download and installation via the internet.
- J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6 BMS COMPATIBILITY

- A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.
- B. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

- C. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.7 SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

- A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.
- B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.
- C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or CO₂.
- D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc).
- E. Energy savings data shall be calculated for the system as a whole or for individual zones.
- F. A time scaled graph showing all relay transitions shall be presented.
- G. A time scaled graph showing a zones occupancy time delay shall be presented
- H. A time scaled graph showing the total light level shall be presented.
- I. User shall be able to customize the baseline run-time hours for a space.
- J. User shall be able to customize up to four time-of-day billing rates and schedules.
- K. Data shall be made available via a .CSV file

2.8 START-UP & SUPPORT FEATURES

- A. To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.
- E. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
- F. All sensor devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.

2.9 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Specification Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- B. Classes 2 and 3 Control Cable: Multiconductor cable, Category 5e with solid-copper conductors not smaller than No. 23 AWG. Comply with requirements in Specification Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Specification Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

PART 3 EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with requirements in Specification Section 260519 – Low- Voltage Electrical Cables. Minimum conduit size shall be ½ inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower- limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Specification Section 260573 – Identification for Electrical Systems.
- B. Identify circuits or luminaries controlled by occupancy sensors at each sensor.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
- B. Lighting control devices that fail tests and inspections are defective work.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits per building (total of 12) to Project during non-occupancy hours for this purpose.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections and assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
 - 3. Test for circuit continuity.
 - 4. Verify that the control module features are operational.
 - 5. Check operation of local override controls.
 - 6. Test system diagnostics by simulating improper operation of several components selected by Architect.

3.7 SOFTWARE INSTALLATION

- A. Install and program system software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.8 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. At least 8 hours of training shall be included covering maintenance, troubleshooting, module replacement, adjustment, and software configuration.

END SECTION 26 09 23

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PART 1 GENERAL

1.1 RELATED WORK AND REQUIREMENTS

- A. Section 260553 – Identification for Electrical Systems
- B. Section 260573 – Overcurrent Protective Device Coordination Study

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Disconnecting and Overcurrent Protective Devices.

1.3 REFERENCES

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

- ECIA 416 (1974; R 1981) Filters for Radio Interference
- ECIA/IS 46 (1987) Test Procedure for Resistance to Soldering (Vapor Phase Technique) for Surface Mount Devices

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- NEMA 250 (2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
- NEMA PB 1 (2011) Panelboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

- UL 489 (2013; Reprint Mar 2014) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
- UL 67 (2009; Reprint Apr 2015) Standard for Panelboards

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended location and application.
- B. Comply with NEMA PB 1.2 and PB 1.2.
- C. National Electrical Contractor's Association (NECA).
- D. Underwriter's Laboratory Inc. (UL) Standards 50, 67, 869, and 468A.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards.
- B. Do not store panelboards exposed to weather.
- C. Handle and prepare panelboards for installation according to NEMA PB 1.
- D. Protect panelboards against damage from work of other trades.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with freestanding panelboards with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP)
Types: spares for each panelboard as shown on one of the Panel Schedules.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush and surface mounted cabinets. Refer to panel schedule and floor plans for types of panel cabinets required.
 - 1. Indoor Dry and Clean Locations: NEMA 250, type 1.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top or bottom. Mains location is at the contactor's option as project conditions dictate, unless specifically indicated otherwise on the drawings.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus-Configured Terminators: Compression type. Lugs shall be of sizes as required to accept feeders as indicated on the drawings.
 - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Cutler Hammer type distribution panelboards or comparable product by one of the following. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
 - 1. Eaton Electrical Inc.; Cutler-Hammer.

2. Schneider Electric; Square D, Inc.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or main lugs only as indicated on the one line diagram and the Panel Schedules.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or plug-in circuit breakers, where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Cutler Hammer series panelboards or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. Schneider Electric; Square D, Inc.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or main lugs only as indicated on the one line diagram or on the Panel Schedule.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTION AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Square D; a brand of Schneider Electric.
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
- C. Circuit Breakers for Multi-wire Circuits. Multi-wire branch circuits shall have a means to simultaneously disconnect all ungrounded conductors by approved circuit breaker handle ties.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to manufacturer's written instructions, according to NEMA PB 1.1, and in accordance with recognized industry practices.
- B. Support panel cabinets independently to structure with no weight bearing on conduits.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount so that top breaker is not higher than 6'-0" AFF, unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush and tight with wall finish and mating with back box.

- F. Adjacent panel cabinets shall be of same physical size and mounted in horizontal alignment.
- G. Install overcurrent protective devices and controllers not already factory installed. Set field-adjustable circuit-breaker trip ranges.
- H. Install filler plates in unused spaced.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 - Identification for Electrical System.
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Verify actual room names and numbers to be used.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 - Identification for Electrical Systems.
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 – Identification for Electrical System.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Megger check and test insulation resistance for each panelboard bus, component, connection supply, feeder, and control circuit. Do not megger check solid state components.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Panelboards will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
- E. Touch up paint scratched and marred surfaces to match original finish.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END SECTION 26 24 16

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PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Isolated-ground receptacles.
3. Wall-switches.

1.2 REFERENCES

A. ANSI/NFPA 70 – National Electrical Code (NEC) 2014

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 DEVICE COLORS

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Isolated-Ground Receptacles: As specified above with Orange triangle on face.

2.2 GENERAL

- A. Provide factory-fabricated wiring devices in type, color, and electrical rating for service indicated.
- B. See Symbol Schedule on drawings for identification of device type.
- C. Terminal screws shall be back and side wired and accept #14, 12, and #10 AWG stranded or solid wire.
- D. A full wrap-around bridge strap shall be provided with locking tabs to secure receptacle face.
- E. Receptacle face shall be impact resistant nylon.

2.3 STRAIGHT BLADE RECEPTACLES

- A. Heavy-Duty, Simplex: Provide single heavy duty type receptacles, 2 pole, 3 wire, grounding, with green hexagonal equipment ground screw, 20 ampere, 125 volts, with NEMA configuration 5-20R unless otherwise indicated.

Pass & Seymour	Hubbell	Leviton
5361	HBL5361	5361

- B. Heavy-Duty Duplex: Provide heavy duty duplex receptacles, 2 pole, 3 wire, grounding, 20 ampere, 125 volts, with NEMA configuration 5-20R unless otherwise indicated.

Pass & Seymour	Hubbell	Leviton
5362	HBL5362	5362

- C. Ground-Fault Circuit Interrupters: Provide ground fault circuit interrupter, with heavy duty duplex receptacles, capable of being installed in a 2-1/2 inch deep outlet box without adapter. Shall be grounding type UL-rated Class A, Group 1, rated 20 amperes, 120 volts, 60 Hz; with solid-state ground fault sensing and signaling; with 5 millamperes ground fault trip level. Equip with NEMA configuration 5-20R receptacle.

1. Test and reset buttons shall match color of face.
2. GFCI receptacles shall meet 2003 UL requirements.
3. If critical components within receptacle are damaged and the ground fault protection is lost, power to receptacle shall be automatically disconnected within the device.

Pass & Seymour	Hubbell	Leviton
2094	GFR5352	8899

- D. Duplex Convenience Isolated Ground Receptacles: Provide single heavy duty type receptacles, 2 pole, 3 wire, grounding, with green hexagonal equipment ground screw, 20 ampere, 125 volts with NEMA configuration 5-20R unless otherwise indicated. Device color shall match non isolated ground receptacles and have an orange triangle on the device.

Pass & Seymour	Hubbell	Leviton
IG6300	IG5362	5362IG

2.4 SWITCHES

A. General:

1. Switches shall be rated for 20 amperes, 120/277 volts AC, and shall be manufacturer's specification grade toggle switch with thermoplastic abuse resistant toggle, quiet action, and heavy duty contact arm.
2. Switches shall have quiet action mechanism with silver alloy contacts for longevity.
3. Terminal screws shall be back and side wire and accept #14, 12, and 10 AWG stranded or solid wire.
4. Switches shall have a backwire pressure plate ground screw mechanism accepting #14, 12, and 10 AWG stranded or solid wire.

B. Single pole:

Pass & Seymour	Hubbell	Leviton
PS20AC1	HBL1221	1221-2

C. Three Way:

Pass & Seymour	Hubbell	Leviton
PS20AC3	HBL1223	1223-2

D. Four Way:

Pass & Seymour	Hubbell	Leviton
PS20AC4	HBL1224	1224-2

E. Key Switch – add suffix 'KL' to above part numbers.

F. See Section 260923 Network Lighting Control Devices for low voltage lighting control switches.

2.5 WIRING DEVICE ACCESSORIES

A. Wall Plates:

1. Provide wall plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; wall plates colored to match wiring devices. Provide plates possessing the following additional construction features:
 - a. Material and Finish:
 - 1) Stainless Steel (0.04 inch thick type 302 satin finished)
 - 2) Nylon, smooth - color to match device
2. Device plates for surface mounted Type FS or FD boxes: Type FSK galvanized steel covers.
3. Device plates for surface mounted, 4 in. square boxes: 1/2 in. raised galvanized steel covers.

B. Weatherproof Covers:

1. Weatherproof covers for all 125-250 volt, 15 and 20 ampere receptacles installed outdoors in a wet location shall be weatherproof, NEMA 3R, with hinged outlet enclosure rated for rain proof protection while outlet is in use. The unit shall be furnished with a neoprene gasket between the mounting surface and the enclosure, and between the mounting plate and the hinged cover to assure proper seal. Shall be equal to Pass & Seymour, Die Cast with GFI mounting plate, Catalog # WIUFC10S.
2. Weatherproof covers for all other receptacles shall be cast aluminum with a gasketed cover. Shall be equal to Hubbell CWP26H (standard flush box) or Hubbell WPFS26 (surface FS box).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. All exterior receptacles shall be GFI type mounted in weatherproof boxes.
- C. Ground receptacles with the insulated green ground wire from device ground screw to a bolted outlet box connection. Isolated ground receptacles shall have the second ground wire (green with yellow tracer) ground the receptacle.
- D. The Contractor shall check the switch location against the Architectural plans and shop drawings to be certain that switches are on the strike side of the door, regardless of swing shown on drawings. Edge of plate shall be not more than 12" from door frame.
- E. Ground-fault circuit interrupter type receptacles may provide GFI protection for downstream receptacles on same circuit only where located in same room as other receptacles.

3.2 FIELD QUALITY CONTROL

- A. Coordination with Other Trades:
 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- B. Conductors:
 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

C. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect connectors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

D. Receptacle Orientation: Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top bottom. Group adjacent switches under single, multi-gang wall plates where devices permit.

3.3 IDENTIFICATION

A. Comply with Section 260553 - Identification for Electrical Systems. For receptacles, identify panelboard and circuit number from which served on device plate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test instruments: Use instruments that comply with UL 1436.
2. Test receptacles with Hubbell 5200, Woodhead 1750, or equal, for correct polarity, proper ground connection, and wiring faults.
3. Test straight blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

END SECTION 26 27 26

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PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches enclosed controllers, and motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches.
3. Spare-fuse cabinets.

1.2 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.3 SUBMITTALS FOR REVIEW/RECORD

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches (as applicable).
5. Ambient temperature adjustment information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse ratings, local ambient temperature, and adjusted fuse ratings.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

PART 2 PRODUCTS

2.1 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages. Fuses shall include indicator windows or provide add-on indicators.

1. Fuse Pullers: For each size of fuse, provide a fuse puller for owners use.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment as designated on design documents.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings. Adjustment factors to be applied per manufacturer recommendations.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

- 1. Service Entrance: Class L, time delay.
- 2. Motor Branch Circuits: Class RK5, time delay.
- 3. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) as directed by owner.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 05 53 – “Identification for Electrical Systems” and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket and holder.

END OF SECTION

DIVISION 26 - ELECTRICAL
SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED WORK AND REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems
- B. Section 26 05 73 - Overcurrent Protective Device Coordination Study
- C. Section 26 28 13 – Fuses
- D. Section 26 29 13 - Enclosed Controllers

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Molded-case circuit breakers (MCCB's).
 - 4. Molded-case switches.
 - 5. Enclosures.

1.3 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.4 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces with all trades. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Provide spare fuse cabinets, Bussmann type SFC, to store all spare fuses. Locate cabinets as directed by the Owner.
 - 3. Fuse Pullers: Provide two for each size and type.

1.6 SUBMITTALS FOR REVIEW/RECORD

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
1. Enclosure types and details for types.
 2. Current, horsepower, and voltage ratings.
 3. Short-circuit current rating.
 4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.7 SUBMITTALS FOR RECORD ONLY

- A. Test Reports: See Project Specification Section # 26 91 00
1. Megger Test Report: Only Service Entrance, >400A, or <400A Critical Applications
 2. Infrared Scanning via FLIR Camera Software
- B. O&M Data

PART 2 PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturer: The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
1. Square D; a brand of Schneider Electric.
 2. Eaton Electrical, Inc.; Cutler-Hammer Business Unit.
 3. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 6. Lugs: Set screw type, suitable for number, size, and conductor material.

2.2 NON-FUSIBLE SWITCHES

- A. Manufacturer: The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
1. Square D; a brand of Schneider Electric.
 2. Eaton Electrical, Inc.; Cutler-Hammer Business Unit.
 3. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 6. Lugs: Set screw type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturer: The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
1. Square D; a brand of Schneider Electric.
 2. Eaton Electrical, Inc.; Cutler-Hammer Business Unit.
 3. Siemens Energy & Automation, Inc.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents indicated on the drawings.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits in each pole. Adjustable magnetic trip setting for circuit-breaker frame sizes 150 A and larger, adjustable from the front.
- D. Construct with over center, trip-free toggle type operating mechanisms with quick make, quick break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position and operating in ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs. AL/CU rated. Lugs shall be adequate to accept wire size indicated on the drawings.
- E. Electronic Trip (shunt trip) Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:

1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I²t response.
- F. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter- style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA or more trip and hold below 4mA of ground fault current). One way circuit length shall not exceed 250 feet. If length exceeds 250 feet, notify engineer in writing prior to installing circuit.
- H. Where required to achieve system coordination with upstream and downstream overcurrent devices, solid-state circuit breakers shall be provided. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be toroid construction, encased in a plastic housing, filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as described below;
1. Longtime current pick up.
 2. Adjustable long time delay.
 3. Short time current pick up.
 4. Adjustable short time delay.
 5. Short time I square times t switch.
 6. Instantaneous current pick up.
 7. Ground fault current pick up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground fault current at the main bonding jumper or ground strap shall not be permitted. Provide ground fault only where indicated on the drawings.
 8. Overload and short circuit and ground fault trip indicators shall be provided.
- I. Interrupting ratings shall be as follows, unless otherwise indicated on drawings. Circuit breakers shall be fully rated for available fault current. Series rating is not acceptable.
- J. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Set screw type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self- powered for solid state type trip units and remote-mounted and powered for magnetic type

trip units with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact. Voltage as shown on project drawings.
6. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.

2.4 MOLDED-CASE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D I-Line Style switches or comparable product by one of the following. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Set screw type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Alarm Switch: One NO contact that operates only when switch has tripped.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 12.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height (as noted on project drawings) unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
 - 1. Examine fusible equipment for size and type of fuse to ensure selective coordination. Provide fuses of size and type as required by equipment manufacturer.
 - 2. Install fuses only after fault and coordination study has been finalized.
 - 3. Fuses shall not be installed until equipment is ready to be energized. If fuse size is too small to physically fit in disconnect switch, provide fuse reduction kit.
- D. Circuit breakers and molded case switches shall be factory installed in enclosures.
- E. 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.
- F. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 - Identification for Electrical Systems.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections to verify that installation has been performed as noted in installation section above.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Test and/or permanently record the following:
1. Fuses:
 - a. Equipment nameplate requirement.
 - b. Actual fuse rating.
 2. Circuit Breakers:
 - a. Nameplate data.
 - b. Actual trip settings.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 – Overcurrent Protective Device Coordination Study. Adjustable settings on circuit breakers shall be set to provide selective coordination, proper operation, and compliance with NEC.

END SECTION 26 28 16

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 189.1 (2011) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

ASHRAE 90.1 - IP (2010) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M (2015) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened

ASTM A580/A580M (2015) Standard Specification for Stainless Steel Wire

ASTM A641/A641M (2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

ASTM A653/A653M (2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B164 (2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire

ASTM B633 (2015) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

ASTM D4674 REV A (2002; R 2010) Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24 (2008; Effective Jan 2010) California's Energy Efficiency Standards for Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10 (2011; Errata 2015) IES Lighting Handbook

IES LM-79	(2008) Electrical and Photometric Measurements of Solid-State Lighting Products
IES LM-80	(2015) Measuring Lumen Maintenance of LED Light Sources
IES RP-16	(2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering
IES TM-21	(2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015; INT 12 2016) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.43	(2013) Electric lamps: Single-Ended Metal Halide Lamps
ANSI C78.389	(2004; R 2009) American National Standard for Electric Lamps - High Intensity Discharge (HID) - Methods of Measuring Characteristics
ANSI C78.901	(2005) American National Standard for Electric Lamps - Single Base Fluorescent Lamps--Dimensional and Electrical Characteristics
ANSI C82.2	(2002) American National Standard for Lamp Ballasts--Methods of Measurement of Fluorescent Lamp Ballasts
ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
ANSI/NEMA C78.LL 1256	(2003; R 2015) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP)
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ANSLG C78.377	(2015) American National Standard for Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA ANSLG C78.81	(2014) American National Standard for Electric Lamps-- Double-Capped Fluorescent Lamps--Dimensional and Electrical Characteristics
NEMA ANSLG C82.11	(2011) Lamp Ballasts - High-Frequency Fluorescent Lamp Ballasts
NEMA ANSLG C82.14	(2006) Lamp Ballasts Low-Frequency Square Wave Electronic Ballasts -- for Metal Halide Lamps
NEMA ANSLG C82.9	(2010) American National Standard for Lamp Ballasts— High- Intensity Discharge and Low-Pressure Sodium Lamps— Definitions
NEMA C78.376	(2014) Electric Lamps — Specifications for the Chromaticity of Fluorescent Lamps
NEMA C78.LL 3	(2003; R 2015) Electric Lamps - Procedures for High Intensity Discharge Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure
NEMA C82.77	(2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA SSL 1	(2010) Electronic Drivers for Led Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NEMA SSL 7A	(2015) Phase-Cut Dimming for Solid State Lighting: Basic Compatibility
NEMA WD 1	(1999; R 2015) Standard for General Color Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2015; ERTA 2015) Life Safety Code
NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint Dec 2013) High-Intensity-Discharge Lamp Ballasts
UL 1472	(2015) UL Standard for Safety Solid-State Dimming Controls
UL 1598	(2008; Reprint Oct 2012) Luminaires
UL 20	(2010; Reprint Feb 2012) General-Use Snap Switches
UL 2043	(2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment
UL 844	(2012) Standard for Luminaires for Use in Hazardous (Classified) Locations
UL 8750	(2009; Reprint May 2014) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products
UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment
UL 917	(2006; Reprint Aug 2013) UL Standard for Safety Clock-Operated Switches
UL 924	(2006; Reprint Dec 2015) Standard for Emergency Lighting and Power Equipment
UL 935	(2001; Reprint Aug 2014) Standard for Fluorescent-Lamp Ballasts
UL 94	(2013; Reprint Jan 2016) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires or luminaire accessories are specified in Section **26 20 00 INTERIOR DISTRIBUTION SYSTEM**. Luminaires and accessories mounted on exterior surfaces of buildings are specified in Section **26 56 00 EXTERIOR LIGHTING**.

1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100 and IES RP-16.
- B. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.
- C. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute

photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

- D. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Shop Drawings
Luminaire Drawings
Occupancy/Vacancy Sensor Coverage Layout

Product Data
Luminaires
Light Sources
Drivers, Ballasts and Generators
LED Luminaire Warranty
Luminaire Design Data
Vacancy Sensors
Dimming Controllers (Dimmers)
Lighting Contactor
Timeswitch
Exit Signs
Emergency Lighting Unit (EBU)
LED Emergency Drivers
Occupancy Sensors
Ambient Light Level Sensor

Test Reports
LED Luminaire - IES LM-79 Test Report
LED Light Source - IES LM-80 Test Report
LED Light Source - IES TM-21 Test Report
Occupancy/Vacancy Sensor Verification Tests

Certificates
Luminaire Useful Life Certificate
LED Driver and Dimming Switch Compatibility Certificate

1.5 QUALITY CONTROL

A. Luminaire Drawings

- a. Include dimensions, accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data must accompany shop drawings.
1. Occupancy/Vacancy Sensor Coverage Layout
Provide floor plans showing coverage layouts of all devices using manufacturer's product information.
2. LED Driver and Dimming Switch Compatibility Certificate
Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices.

3. Luminaire Design Data
 - a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified per the NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).
 - b. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections must be obtained from testing in accordance with IES LM-80
4. LED Luminaire - IES LM-79 Test Report
 - a. Submit test report on manufacturer's standard production model luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in IES LM-79.
5. LED Light Source - IES LM-80 Test Report
 - a. Submit report on manufacturer's standard production LED light source (package, array, or module). Include all applicable and required data as outlined under "8.0 Test Report" in IES LM-80.
6. LED Light Source - IES TM-21 Test Report
 - a. Submit test report on manufacturer's standard production LED light source (package, array or module). Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in IES TM-21.
7. Occupancy/Vacancy Sensor Verification Tests
 - a. Submit test report outlining post-installation coverage and operation of sensors.
8. Test Laboratories
 - a. Test laboratories for the IES LM-79 and IES LM-80 test reports must be one of the following:

National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.
One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List at for LM-79 testing.
One of the EPA-Recognized Laboratories listed at for LM-80 testing.
9. Regulatory Requirements
 - a. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated.
10. Standard Products

- a. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

B. Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1. Material and Equipment Manufacturing Date

- a. Products manufactured more than six months prior to date of delivery to site must not be used, unless specified otherwise.

2. Energy Efficiency

- a. Submit data indicating lumens per watt efficacy and color rendering index of light source.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

A. LED Luminaire Warranty

- b. Provide a written 10 year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.
- c. Include finish warranty to include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
- d. Material warranty must include:
 - (1) All drivers.
 - (2) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.Warranty period must begin on date of beneficial occupancy. Provide the Owner with signed warranty certificates prior to final payment.
- e. Provide Luminaire Useful Life Certificate
- f. Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be luminaires, luminaire controls, or associated equipment are specified in Section **26 20 00** INTERIOR DISTRIBUTION SYSTEM. Luminaires, luminaire controls, and associated equipment for exterior applications are specified in Section **26 56 00** EXTERIOR LIGHTING.

2.2 LUMINAIRES

UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.

A. LED Luminaires

- a. Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires. LED luminaires must meet the minimum requirements in the following table:

LUMINAIRE TYPE	MINIMUM LUMINAIRE EFFICACY (LE)	MINIMUM COLOR RENDERING INDEX (CRI)
LED TROFFER - 1 x 4 2 x 2 2 x 4	90 LPW	80
LED Downlight	50 LPW	90
LED Track or Accent	40 LPW	80
LED Low Bay/High Bay	80 LPW	70
LED Linear Ambient	80 LPW	80

- b. LED luminaires must also meet the following minimum requirements:

- c. Luminaires must have a minimum 10 year manufacturer's warranty.

1. Luminaires must have a minimum L70 lumen maintenance value of 50,000 hours as calculated by IES TM-21, with data obtained per IES LM-80 requirements.
2. Luminaire drive current value must be identical to that provided by test data for luminaire in question.
3. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.
4. Luminaires must be listed with the Design Lights Consortium 'Qualified Products List' when falling into category of "General Application" luminaires, i.e. Interior Directional, Display Case, Troffer, Linear Ambient, or Low/High Bay. Requirements are shown in the Design Lights

Consortium "Technical Requirements Table" at <https://data.energystar.gov/dataset/EPA-Recognized-Laboratories-For-Lighting-Products/jgwf-7qrr>.

5. Provide Department of Energy 'Lighting Facts' label for each luminaire.

2.3 DRIVERS, BALLASTS and GENERATORS

A. LED Drivers

- a. NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:
- b. Output power (watts) and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.
Power Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.
Current draw Total Harmonic Distortion (THD) of less than 20 percent.
Class A sound rating.
Operable at input voltage of 120-277 volts at 60 hertz.
Minimum 10 year manufacturer's warranty.
RoHS compliant.
Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.
UL listed for dry or damp locations typical of interior installations.
Fully-dimmable using 0-10V control, or as indicated in luminaire schedule.

1. LED Light Sources

- a. Correlated Color Temperature (CCT) of 4000 or 5000 degrees K. Refer to Lighting Fixture Schedule.
- b. Minimum Color Rendering Index (CRI) R9 value of 80.
- c. High power, white light output utilizing phosphor conversion (PC) process.
- d. RoHS compliant.
- e. Provide light source color consistency by utilizing a binning tolerance within a 4 step MacAdam ellipse.

2.4 LIGHTING CONTROLS

See also Section 260923 Lighting Controls, and Section 262726 Wiring Devices. ASHRAE 90.1 - IP ASHRAE 189.1. Provide network certification for all networked lighting control systems and devices.

A. Lighting Contactor

1. NEMA ICS 2. Provide an electrically-held lighting contactor housed in a NEMA 1 enclosure conforming to NEMA ICS 6. Provide contactor with one normally-open (NO), single pole contacts, rated 600 volts, 30 amps. Provide coil operating voltage of 120 volts.

2. Timeswitch

- a. Provide electronic type timeswitch with a 24 hour/7 day astronomic programming function that changes on/off settings according to seasonal variations of sunset and sunrise, providing a total of 56 on/off set points. Provide 2 hour AM/PM type digital clock display format. Provide power outage back-up for switch for a minimum of seven days. Provide switch capable of controlling a minimum of 4 channels or loads. Rate contacts at 30 amps at 120/277 volts for general purpose loads. Provide contacts in a SPST, normally-open (NO) configuration. Provide switch with function that allows automatic control to be skipped on certain selected days of the week, manual bypass or remote override control, daylight savings time adjustment, additional memory module, momentary function for output contacts and ability for photosensor input.
- b. House timeswitch in a surface-mounted, lockable, NEMA 1 enclosure constructed of painted steel or plastic polymer conforming to NEMA ICS 6.

2.5 EXIT AND EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 101, and NFPA 70 compliant.

A. Exit Signs

Provide exit signs consuming a maximum of five watts total.

- a. LED Self-Powered Exit Signs
- b. Provide in thermo-plastic, die-cast aluminum housing with UL label, configured for ceiling, end or wall mounting. [Provide edge-lit type with clear acrylic, edge-lit face and aluminum trim having clear aluminum white finish. Provide 6 inch high, 3/4 inch stroke red lettering on face of sign. Provide chevrons on either side of lettering to indicate direction. Provide single or double face. Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1 1/2 hours. LEDs must have a minimum rated life of 10 years. Provide self-diagnostic circuitry integral to emergency LED driver.

3. LED Remote-Powered Exit Signs

Provide as indicated above for self-powered type, but without battery and charger. Exit sign must contain provision for 120/277 VAC or 6-48 VDC input from remote source.

B. Emergency Lighting Unit (EBU)

1. Provide in UV-stable, thermo-plastic, painted, die-cast aluminum, or painted steel housing with UL label. Emergency lighting units must be rated for 12 volts, except units having no remote-mounted lamps and having no more than two unit-mounted light sources may be rated six volts. Equip units with brown-out sensitive circuit to activate battery when input voltage falls to 75 percent of normal. Equip with two LED type light sources, automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1 1/2 hours. LEDs must have a minimum rated life of 10 years. Provide self-diagnostic circuitry integral to emergency LED driver.
2. LED Emergency Drivers

- a. Provide LED emergency driver with automatic power failure detection, test switch and LED indicator (or combination switch/indicator) located on luminaire exterior, and fully-automatic solid-state charger, battery and inverter integral to a self-contained housing. Provide self-diagnostic function integral to emergency driver. Integral battery is required to supply a minimum of 90 minutes of emergency power at rated watts, compatible with LED forward voltage requirements, constant output. Driver must be RoHS compliant, rated for installation in plenum-rated spaces and damp locations, and be warranted for a minimum of five years.
3. Self-Diagnostic Circuitry for LED and Fluorescent Emergency Drivers/Ballasts
 - a. Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a one minute diagnostic test every 28 days, and a 30 minute diagnostic test every six months, minimum. Any malfunction of the unit must be indicated by LED(s) visible from the exterior of the luminaire. A manual test switch must also be provided to perform a diagnostic test at any given time.

2.6 LUMINAIRE SUPPORT HARDWARE

A. Wire

1. ASTM A641/A641M; Galvanized, soft tempered steel, minimum 0.11 inches in diameter, or galvanized, braided steel, minimum 0.08 inches in diameter.
2. Wire for Humid Spaces
 - a. ASTM A580/A580M; Composition 302 or 304, annealed stainless steel, minimum 0.11 inches in diameter.
 - b. ASTM B164; UNS NO4400, annealed nickel-copper alloy, minimum 0.11 inches in diameter.
3. Threaded Rods
 - a. Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.
4. Straps
 - a. Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.7 EQUIPMENT IDENTIFICATION

A. Manufacturer's Nameplate

1. Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.
2. Labels

Provide labeled luminaires in accordance with UL 1598 requirements. All luminaires must be clearly marked for operation of specific light sources and ballasts, generators or drivers.

3. Light source type, wattage, envelope type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

4. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

All markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. Ballasts, generators or drivers must have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

- A. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of NEMA 250 corrosion-resistance test.

2.9 RECESS- AND FLUSH-MOUNTED LUMINAIRES

- A. Provide access to lamp and ballast from bottom of luminaire. Provide trim and lenses for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications.

2.10 SUSPENDED LUMINAIRES

- A. Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers. Provide with swivel hangers to ensure a plumb installation. Provide cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers must allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended luminaires must have twin-stem hangers. Multiple-unit or continuous row luminaires must have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Provide rods with a minimum 0.18 inch diameter.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein. Install luminaires and lighting controls to meet the requirements of ASHRAE 90.1 - IP and ASHRAE 189.1. To encourage consistency and uniformity, install luminaires of the same manufacture and model number when residing in the same facility or building.

A. Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature, color rendering index, and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

1. Luminaires

- a. Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Installation must meet requirements of NFPA 70. Mounting heights specified or indicated must be to the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain approval of the exact mounting height on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed luminaires must be independently supported from the building structure by

a minimum of four wires, straps or rods per luminaire and located near each corner of the luminaire. Ceiling grid clips are not allowed as an alternative to independently supported luminaires. Round luminaires or luminaires smaller in size than the ceiling grid must be independently supported from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around. Do not support luminaires by acoustical tile ceiling panels. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire. Provide wires, straps, or rods for luminaire support in this section. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

2. Suspended Luminaires

- a. Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level. Locate so that there are no obstructions within the 45 degree range in all directions. The stem, canopy and luminaire must be capable of 45 degree swing. Pendants, rods, or chains 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation. Suspended luminaires in continuous rows must have internal wireway systems for end to end wiring and must be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints. Support steel luminaires to prevent "oil-canning" effects. Luminaire finishes must be free of scratches, nicks, dents, and warps, and must match the color and gloss specified. Match supporting pendants with supported luminaire. Aircraft cable must be stainless steel. Canopies must be finished to match the ceiling and must be low profile unless otherwise shown. Maximum distance between suspension points must be 10 feet or as recommended by the manufacturer, whichever is less.

3. Ballasts, Generators and Power Supplies

- a. Typically, provide ballasts, generators, and power supplies (drivers) integral to luminaire as constructed by the manufacturer.

4. Exit Signs and Emergency Lighting Units

- a. Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

5. Photocell Switch Aiming

- a. Aim switch according to manufacturer's recommendations.

3.2 FIELD APPLIED PAINTING

A. Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

END SECTION 265100

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PART 1 GENERAL

1.1 SUMMARY

- A. The requirements of this Section apply to, and are a component part of, the 26, 27 and 28 series project specifications, as noted in individual specifications.

1.2 SUBMITTALS FOR REVIEW/RECORD

- A. Submit all field acceptance reports noted in this specification according to the requirements of the individual specifications. Submission should be under each respective specification section, as required, and not this Section.

PART 2 EXECUTION

2.1 INSTALLATION CHECKLISTS / ACCEPTANCE TESTS / REPORTS

- A. Complete all as noted, per individual 26, 27 and 28 series project specifications, in Attachment A.

2.2 TEST REPORT AND CHECKLIST COMPLETION LOG

- A. Maintain and complete log provided in Attachment A

ATTACHMENT A

CABLE REEL INSPECTION

TO BE COMPLETED IF:

Any visible signs of defect when received (Attach Photos)

-- OR --

Manufacturer's certified test report is NOT included with cable upon delivery

-- OR --

Difference between ordered cable and received cable

Basic Reel Info	
Cable ID	
Manufacturer's Name	
Conductor Material	
Conductor Size	
Insulation Type	
Insulation Thickness	
Jacket Thickness	
Temperature Rating	
Length of Cable	
Voltage Class	
Shielded/Non-Shielded	
Date of Manufacture	
Inspection Date	
Inspector Identity	

Fill out available info via reel label or cable jacket.

Date:

Checked By:

Notes:

COVER SHEET

TO BE COMPLETED FOR: *(check one)*

- ☐ **Factory Test Report**
- ☐ **Vendor Start-Up / Field Test Report**
- ☐ **Other:** _____.

Product Information	
Specification Section	
Job Name and Number	
Date	
Foreman	
Equipment ID	
Equipment Type	
Manufacturer	
One-Line Sheet	

Notes:

GROUNDING & BONDING INSTALLATION CHECKLIST

Job Name	Job Number	Building Name
PM	Foreman	QA/QC Inspector
Date	ID	One Line Sheet

ID	NOTES:	YES	NO	N/A	INITIALS
1	Is the system in compliance with drawings, specifications, and NFPA 70 NEC Article 250?				
2	Have physical and mechanical conditions been inspected for continuity?				
3	Are the bolted connections torqued per specification? (<i>NETA Table 100.12.1</i>)				
4	Are all conduits properly bonded?				
5	Are the grounding system's electrical and mechanical connections free of corrosion?				
6	Is the Megger Test complete and acceptable? (<i>NETA Table 100.1</i>)				
7	Has the Point-to-Point Test been completed to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points?				
8	Is the resistance between the main grounding electrode and ground under 5 ohms?				
9	Have the measurements been recorded on the grounding riser one-line for record under As-Built?				

NOTES: Provide reasoning or actions to be taken for items with "Negative" responses.

LOW-VOLTAGE CABLE CHECKLIST

Job Name	Job Number	Building Name
PM	Foreman	QA/QC Inspector
Date	Circuit ID	Cable Type
Voltage Rating	Current Rating	One Line Sheet

ID	DESCRIPTION	YES	NO	N/A	INITIALS
1	Is the cable marking sufficient for the voltage application?				
2	Is the conductor material and size per the drawings?				
3	Is the bending radius acceptable? (<i>NETA Table 100.22</i>)				
4	Is the Megger Test complete and acceptable? (<i>NETA Table 100.1</i>)				
5	Are the bolted connections torqued per specification? (<i>NETA Table 100.12.1</i>)				
6	Are all phase IDs and cable IDs securely in place and acceptable?				
7	Are termination cabinets clean and free of debris?				

NOTES: (*Provide reasoning or actions to be taken for items with "Negative" responses*)

MEGGER TEST REPORT

Job # and Name	Date	Panel
Description	Conductor Size	Raceway Type
Cable Length	Insulation Type	Pipe #

TEST RESULTS

Megger Test Voltage:

1000 V

PHASE A to GROUND	_____	Ω
PHASE B to GROUND	_____	Ω
PHASE C to GROUND	_____	Ω
PHASE A to PHASE B	_____	Ω
PHASE A to PHASE C	_____	Ω
PHASE B to PHASE C	_____	Ω
PHASE A to NEUTRAL	_____	Ω
PHASE B to NEUTRAL	_____	Ω
PHASE C to NEUTRAL	_____	Ω
NEUTRAL to GROUND	_____	Ω

*Fill out what applies

NOTES:

TESTED BY: _____

PANELBOARD INSTALLATION CHECKLIST

Job Name	Job Number	Building Name
PM	Foreman	QA/QC Inspector
Date	Equipment ID	Manufacturer
Voltage Rating	Current Rating	One Line Sheet

ID	DESCRIPTION	YES	NO	N/A	INITIALS
1	Is the unit free of visible damage?				
2	Does the equipment nameplate data match the drawings and specifications?				
3	Is the unit properly labeled with ID tags and warnings?				
4	Are all conductors labeled correctly?				
5	Is the panel installed per drawings?				
6	Is the circuit directory installed and complete?				
7	Are the breakers correctly sized and located per the drawings?				
8	Have all breakers been manually operated and function correctly?				
9	Are the trip units set per the coordination study if required?				
10	Are feeder wires, neutral, and ground sized per plan and specifications?				
11	Has the continuity been checked phase to ground?				
12	Is the unit properly grounded and bonded?				
13	Are bolted connections torqued per specifications? (<i>NETA Table 100.12.1</i>)				
14	Is the interior clean and free of debris?				
15	Has the unit been completely closed? (<i>all covers and filler plates installed and KOs sealed</i>)				
16	Are all wires correctly phased? (<i>A-B-C left to right</i>)				
17	Is the Megger Test complete and acceptable? (<i>NETA Table 100.1</i>)				

NOTES: (*Provide reasoning or actions to be taken for items with "Negative" responses*)

Job # and Name:

Specification Section:

[illegible]

END OF SECTION 26 91 00

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DIVISION 27 – TELECOMMUNICATIONS
SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS 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. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the telecommunications grounding and bonding system as described in the drawings and within this and all associated specification sections.
- B. The drawings indicate the locations of the grounding and bonding system. Data presented on the drawings is as accurate as preliminary surveys and planning can determine. Accuracy is not guaranteed and field verification of all dimensions, routing, etc. is required.
- C. Specifications and drawings are for assistance and guidance, but not exact routing, locations, distances and levels will be governed by actual field conditions. The contractor is directed to make field surveys as part of his work prior to submitting system layout shop drawings.
- D. Related Requirements:
 - 1. Division 27 Section "Pathways for Communication Systems".
 - 2. Division 27 Section "Communications Equipment Room Fittings".

1.3 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code 2014
- B. NEMA VE 1-1998- Metallic Cable Tray Systems
- C. NEMA VE 2-2013 – Cable Tray Installation Guidelines
- D. NEC Compliance - (Article 318) Construction and Installation of Cable Tray
- E. UL Compliance - Provide products that are UL-classified and labeled
- F. BICSI Telecommunications Distribution Methods Manual
- G. IEEE Standard 1100: IEEE Recommended Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book)
- H. ANSI/EIA: TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- I. ANSI/EIA: J-STD-607-A Commercial Building Grounding/ Bonding Requirements

1.4 **DEFINITIONS**

- A. ACEG: Alternating Current Equipment Ground
- B. BC: Bonding Conductor
- C. BCT: Bonding Conductor for Telecommunications: A conductor that interconnects the telecommunications binding infrastructure to the building's service equipment (power) ground.
- D. BICSI: Building Industry Consulting Service International.
- E. Bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.
- F. CBN: Common Bonding Network
- G. EF: Entrance Facility
- H. EMI: Electromagnetic Interference
- I. ER: Equipment Room
- J. GE: Grounding Equalizer
- K. GEC: Grounding Electrode Conductor
- L. LAN: Local area network.
- M. MCBN: Mesh Common Bonding Network
- N. RCDD: Registered Communications Distribution Designer.
- O. TR: Telecommunications Room
- P. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.
- Q. Ground/Earth: A conducting connection, whether intentional or incidental, by which an electric circuit or equipment is connected to earth, or to some conducting body of relatively large extent that serves in place of the earth.
- R. TBB: Telecommunications Bonding Backbone: A copper conductor used to connect the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar (TGB).
- S. TGB: Telecommunications Grounding Busbar: The interface to the building telecommunications grounding system generally located in the telecommunications room or equipment room. A common point of connection for telecommunications system and equipment bonding to ground, and located in the telecommunications room or equipment room.

- T. TMGB: Telecommunications Main Grounding Busbar: A busbar placed in a convenient and accessible location and bonded, by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

1.5 RESPONSIBILITY

- A. The term Electrical Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.
- B. The Electrical Contractor shall be responsible for the following:
 - 1. Providing each Telecommunications Main Grounding Busbar (TMGB) and Telecommunications Grounding Busbar (TGB) and the connection between the TMGB, each TGB and the building electrical grounding system.
 - 2. Providing the grounding and bonding materials and equipment to provide a complete grounding and bonding system for the telecommunications system and associated equipment and connecting that system to the TMGB or TGB.

1.6 BIDDING

- A. At the time of bid, in addition to a complete bid including all pricing information, provide the following:
 - 1. A detailed description of any and all additions, deletions or exceptions taken to the bid documents. Include the reasons why changes are being proposed.
 - 2. Detailed breakout of all requested alternate pricing.
 - 3. A price to furnish and install each individual media type and system component under this proposed work.
 - 4. Any add/delete pricing requested.

1.7 ACTION SUBMITTALS

- A. Product Data: For all parts and pieces of the telecommunications grounding system including but not limited to grounding busbars, terminations, taps, lugs, and conductors. Include construction details, material descriptions, dimensions of individual components and technical data/ cut sheets for each piece of equipment, cable and connector required to provide a complete grounding and bonding system. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.8 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Shop Drawings: For the communications grounding and bonding system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, location and size of each field connection.

2. Wiring Diagrams to show typical grounding and bonding schemes including the following:
 - a. Locations of Telecommunications Main Grounding Busbars (coordinated between the Electrical Contractor installing the TMGB and the Low Voltage Contractor)
 - b. Locations of Telecommunications Grounding Busbars (coordinated between the Electrical Contractor installing the TGB and the Low Voltage Contractor)
 - c. Telecommunications Bonding Backbone topology including bonding conductor sizes (coordinated with the Electrical Contractor installing the TBB)
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing mounting brackets.

C. Qualification Data: For Installer and installation supervisor.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Low Voltage Contractor must have personnel certified by the manufacturer on staff.
 1. Installation Supervision: Installation shall be under the direct supervision of Competent Technician, who shall be present at all times when Work of this Section is performed at Project site.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Grounding: Comply with ANSI-J-STD-607-A.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install grounding and bonding equipment until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.11 PERFORMANCE REQUIREMENTS

- A. The grounding/earthing and bonding system shall create a low impedance path with adequate capacity for electrical surges and transient voltages to return to their source (which may include the earth). This specification focuses on the telecommunications grounding and bonding system, hereafter referred to as the grounding, bonding, or grounding/earthing system.
- B. The grounding/earthing system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment.
 1. Always follow the grounding/earthing recommendations of the manufacturer when installing equipment.

2. Bonding to building steel, electrical conduit and metallic water piping shall not be substituted for the telecommunications bonding backbone (TBB).
 3. Electrical continuity throughout each rack or cabinet shall be required. Hardware typically supplied with bolt-together racks is not designed for grounding/earthing purposes. Rack and cabinet members shall be deliberately bonded utilizing hardware specifically designed to bond individual rack and cabinet members to one another.
 4. Any metallic component that shall be considered part of the telecommunications system, including but not limited to equipment, equipment racks/ cabinets, cable pathways (ladder racks, wire cable basket tray), enclosures, etc. All telecommunications system components shall be bonded to the grounding/earthing system.
- C. Telecommunications systems shall be grounded and bonded in compliance with the requirements and practices of the NEC, except where other codes or authorities have more stringent requirements including applicable ANSI J-STD-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications and Local Building Codes.

PART 2 - PRODUCTS

2.1 STANDARD BUSBARS

- A. Acceptable Manufacturers:
1. Chatsworth Products, Inc.
 2. Erico Eritech
 3. Panduit
 4. Harger
- B. General:
1. Standard busbars are insulated ground bus mounting plates specifically designed for commercial applications.
 2. Standard busbars shall be constructed of electro-tin plated hard-drawn electrolytic tough pitch solid copper.
 3. Standard busbars shall be UL Listed, and meet BICSI and J-STD-607-A requirements for network systems grounding applications.
- C. Busbar Requirements:
1. Telecommunications Main Grounding Busbar (TMGB)
 - a. The TMGB shall be 1/4 inch thick and 4 inches wide.
 - b. The TMGB shall be available in standard lengths of 12 or 20 inches.

- 1) Each 12 inch TMGB shall include a minimum of (12) 1/4 inch with 5/8" spacing and (6) 3/8" inch with 1" spacing holes.
 - 2) Each 20 inch TMGB shall include a minimum of (24) 3/4 inch with 5/8" spacing and (6) 3/8 inch with 1" spacing holes.
 - c. Each TMGB shall accept any lug with a 3/8" bolt.
2. Telecommunications Grounding Busbar (TGB)
- a. The TGB shall be 1/4 inch thick and 2 inches wide.
 - b. The TGB shall be available in standard lengths of 10, 12 or 20 inches.
 - 1) Each 20 inch TGB shall include a minimum of (12) 1/4 inch with 5/8" spacing and (3) 3/8 inch with 1" spacing holes.
 - c. Each TGB shall accept any lug with a 3/8" bolt.
3. Horizontal Rack-Mounted Busbar
- a. Horizontal rack busbars shall be constructed for installation on 19", 23", or 35" standard equipment racks and cabinets that meet EIA-310-D.
 - b. Horizontal rack busbars will be 3/16 inch thick and 3/4 inch wide.
 - c. Horizontal rack busbars shall include a minimum of eight #6-32 tapped lug mounting holes on 1 inch centers and two pairs of 5/16 inch diameter holes spaced 5/8 inch apart for attaching ground jumpers.

2.2 CABLE RUNWAY GROUND STRAP

A. Acceptable Manufacturers:

1. Chatsworth Products, Inc.
2. Erico Eritech
3. Panduit
4. Harger

B. General:

1. Cable runway ground straps provide a ground pathway between cable pathway segments/ runway lengths when fastened together across pathway/ runway splices.
2. Cable runway ground straps shall be constructed of UL Listed components.

C. Size:

1. Each cable runway ground strap shall consist of a minimum 8-inch long #6 AWG green/ yellow insulated stranded copper conductor attached at both ends to two-hole compression lugs.

2. Each compression lug at each end of the conductor shall include two 1/4 inch bolt holes spaced on 5/8 inch centers.

2.3 GROUND JUMPER

- A. Acceptable Manufacturers:
 1. Chatsworth Products, Inc.
 2. Erico Eritech
 3. Panduit
 4. Harger
- B. Ground Jumpers provide common grounding from the equipment, equipment rack or cabinet to the halo conductor, grounding strip or grounding busbar.
- C. Ground Jumpers shall be constructed of minimum #6 AWG green/ yellow insulated stranded copper conductor attached to a compression lug at each end.
- D. Each compression lug at each end of the conductor shall include two 1/4 inch bolt holes spaced on 5/8 inch centers. Compression lugs shall be available with 90° and 45° angles.
- E. Ground jumper shall be available in 2-foot, 3-foot, and 9-foot lengths.
- F. Constructed of UL Listed components.

2.4 TWO MOUNTING HOLE GROUND TERMINAL BLOCK

- A. Acceptable Manufacturers:
 1. Chatsworth Products, Inc.
 2. Erico Eritech
 3. Panduit
 4. Harger
- B. Terminal blocks shall provide a method for attaching ground wires to racks or cabinets.
- C. Terminal blocks shall be constructed of extruded, high-strength aluminum.
- D. Terminal blocks shall accept conductors from #14 AWG through 2/0 AWG.
- E. Each terminal block shall include two #3/8-24 x 7/8 inch stainless steel hex head set screws.
- F. Terminal blocks shall be UL Listed and meet BICSI and ANSI/EIA/TIA two hole mounting recommendations.

2.5 CODE/ FLEX CONDUCTOR TAP

- A. Acceptable Manufacturers:
 - 1. Chatsworth Products, Inc.
 - 2. Erico Eritech
 - 3. Panduit
 - 4. Harger
- B. Code/ Flex conductor taps shall be provide a method for tapping into continuous conductors as a splice or pigtail.
- C. Each tap shall support #6 - #10 AWG, #2 - #6 AWG, 250 kcmil - #2 AWG, and 4/0 - #2 AWG runs and #2 - #6 AWG, #2 - #8 AWG, and #8 - #14 AWG taps.
- D. Each tap groove shall be constructed separately from one another to allow each groove to function independently of one another.
- E. Taps shall be UL Listed and CSA Certified with AWG conductors for applications up to 600V.
- F. Clear high impact plastic covers shall be provided with each tap and shall meet the following requirements:
 - 1. Each cover shall allow complete 360° inspection of the crimp connection to assure that the crimp was made properly.
 - 2. Each cover shall allow labels to be added to and protected by either side of the cover.
 - 3. Each cover shall include molded flash barriers encompassing the tap and crimp to provide protection against electrical flash over.
 - 4. The high impact plastic shall meet the UL 94V-0 flame rating and oxygen index of 28 providing self extinguishing, flame retardant properties.
 - 5. Each cover shall include the part number, voltage rating, and temperature rating molded into the cover.

PART 3 - EXECUTION

3.1 GROUNDING/EARTHING AND BONDING

- A. A Telecommunications Main Grounding Busbar (TMGB) shall be located at the Equipment Room. A Telecommunications Grounding Busbar (TGB) shall be located in each Telecommunications Room. The TGB will be grounded/earthed to the Telecommunications Main Grounding Busbar (TMGB).
- B. The TMGB shall be bonded to the electrical service ground according to J-STD-607-A guidelines. Each TGB shall be bonded to the TMGB of the building.

- C. The gauge of the connecting ground/earth cable, known as the Telecommunications Bonding Backbone (TBB) will follow J-STD-607-A guidelines, as is shown in the table below (verify TBB sizes using the table published by ANSI in the J-STD-607-A standard, the table below is provided for reference only).

Sizing of the TBB

TBB Length in Linear meters (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
Greater than 20 (66)	3/0

- D. Route the TBB to each TGB in as straight a path as possible. The TBB should be installed as a continuous conductor, avoiding splices unless absolutely necessary. Use the J-STD-607-A guidelines for sizing of the TBB when sizing the GE (shown in the table above).
- E. Any splices in the TBB shall be pre-approved by the engineer or record in writing prior to installation.

3.2 CONSTRUCTION OF THE GROUNDING/EARTHING SYSTEM

- A. Avoid routing grounding/earthing conductors in metal conduits. If the grounding/earthing conductor must be routed through a metal conduit, bond at least one end of the conduit to the grounding/earthing conductor. Use grounding bushing to bond to the conduit, a copper compression fitting with clear cover to bond to the grounding/earthing conductor, and a #6 AWG copper conductor to connect the u-bolt style grounding clamp to the compression fitting.

3.3 WIRE BASKET TRAY BONDING

- A. Wire basket trays shall be bonded per the manufacturer's installation instructions.
- B. Attach a #6 AWG jumper to the Wire Basket Tray with a split bolt. Then use a copper compression tap to attach the other end of the jumper to the mesh CBN. The size of the mesh CBN will determine the size of the copper compression tap.

3.4 LADDER RACK BONDING

- A. Ladder racks shall be bonded per the manufacturer's installation instructions.
- B. To provide electrical continuity between ladder rack segments drill holes in rack and use a #6 AWG code cable with green/yellow stripe to jumper between segments. The jumper shall be made with 2-hole copper compression connectors, terminated on both ends. Once the ladder rack segments are bonded together, the ladder rack system shall be bonded to the TMGB or TGB.

3.5 EQUIPMENT RACK/ CABINET GROUNDING/EARTHING

- A. To provide electrical continuity between equipment rack/ cabinet elements paint piercing grounding washers shall be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack/ cabinet.
- B. Grounding jumpers shall be used to bond the front and rear equipment mounting rails to one another in equipment cabinets when it is not feasible to install the paint piercing washers.
- C. Mount an electrostatic discharge (ESD) port kit directly to the rack grounding strip on the front of the rack at approximately 48 inches from the floor. Use the thread-forming screws provided to form a bond to the rack. Place the ESD protection identification stickers directly above the ESD ports.
- D. When the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. Use the appropriate manufacturer recommended series jumper for the equipment being installed and the thread-forming screws provided in the equipment.
- E. Do not bond racks or cabinets serially. Bond each ground jumper conductor directly to the mesh common bonding network.

3.6 GROUNDING SYSTEM

- A. The communications grounding system shall adhere to the recommendations of the ANSI/TIA-942 and J-STD-607-A standards, and shall be installed in accordance with best industry practice.
- B. A licensed electrical contractor shall perform installation and termination of the main bonding conductor to the building service entrance ground.

3.7 WORKMANSHIP

- A. The ground/earth system must be designed for high reliability. Therefore, the grounding/earthing system shall meet following criteria:
 - 1. Local electrical codes shall be adhered to.
 - 2. The grounding/earthing system shall comply with ANSI/TIA-942 and J-STD-607-A.
 - 3. All grounding/earthing conductors shall be copper.
 - 4. Lugs, copper compression taps, grounding strips, and busbars shall be UL Listed and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.
 - 5. Wherever possible, two-hole lugs shall be used. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).

6. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
7. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.

3.8 PENETRATIONS OF WALLS, FLOORS AND CEILINGS

- A. The Electrical Contractor shall receive written approval from the engineer of record prior to making any penetrations through floors, rated walls or ceiling not indicated on the contract documents.
- B. Sealing penetrations – The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Low Voltage Contractor who pulled or placed the cables.
 1. Where penetrations through acoustical walls or other walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor in compliance with applicable code requirements and as directed by Owner's Architect or Owner.
 2. Where penetrations through fire-rated walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor as required by code and as directed by Owner's Architect or General Contractor.

3.9 COMPLETION OF WORK

- A. At the completion of the Work, the Low Voltage Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.
- B. All clean up, restoration, and removal noted above will be by the Low Voltage Contractor and at no additional cost.

END SECTION 27 05 26

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DIVISION 27 – TELECOMMUNICATIONS
SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS

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. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the horizontal cable pathway system of non-continuous cable supports, conduit or cable tray as described in the drawings.
- B. The drawings indicate the general route of the raceway system. Data presented on the drawings is as accurate as preliminary surveys and planning can determine. Accuracy is not guaranteed and field verification of all dimensions, routing, etc. is required.
- C. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.
- D. Section Includes:
 - 1. Non-continuous Cable Support
 - 2. Wire Basket Support Systems
 - 3. Ladder Rack Support Systems
 - 4. Flexible Raceway Systems
 - 5. Conduits and Sleeves
 - 6. Boxes, enclosures, and cabinets.
- E. Related Requirements:
 - 1. Division 27 Section "Grounding and Bonding for Communications Systems"
 - 2. Division 27 Section "Communications Equipment Room Fittings".
 - 3. Division 27 Section "Communication Backbone Cabling".
 - 4. Division 27 Section "Communication Horizontal Cabling".

1.3 REFERENCES

- A. ANSI/NFPA 70 – National Electrical Code (NEC) 2014
- B. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- C. ASTM A653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process
- D. ASTM A123 – Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel
- E. ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- F. ASTM A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
- G. ASTM A 580 – Standard Specification for Stainless Steel Wire
- H. ASTM D 769 – Standard Specification for Black Oxide Coatings
- I. NEMA VE 1-2002 – Metal Cable Tray Systems
- J. NEMA VE 2-2013 – Cable Tray Installation Guidelines
- K. UL Compliance - Provide products that are UL-classified and labeled
- L. ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- M. ANSI/TIA J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- N. IEC 61537 (2001) – Cable Tray Systems and Cable Ladder Systems for Cable Management
- O. BICSI Telecommunications Distribution Methods Manual

1.4 DEFINITIONS

- A. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.
- B. EMT: Electrical Metal Tubing
- C. ENT: Electrical Non-Metallic Tubing
- D. GRC: Galvanized Rigid Conduit
- E. IMC: Intermediate metal conduit.

F. RMC: Rigid Metal Conduit

1.5 DESCRIPTION

- A. This system consists of empty raceways as shown on the drawings and described herein.
- B. Horizontal pathways consist of structure that conceal, protect, support and provide access to horizontal cables between the telecommunication outlet/connector at the work area and the horizontal cross-connect in the serving area.
- C. Where ceiling areas are used as pathways for telecommunication cables and connecting hardware follow all applicable rules covering installations in both air plenums and non-plenum hollow-ceiling systems as found in the applicable electrical and building codes and standards.

1.6 RESPONSIBILITIES

- A. The term Electrical Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives used in this specification document to produce the finished product described here.
- B. The Electrical Contractor shall be responsible for providing all:
 - 1. Equipment, basket Cable Tray, J-hooks/Rings, Ladder Rack and associated support, splices, terminating hardware, etc. as necessary to provide a functional cable support system.
 - 2. Back-boxes, pull-boxes, junction boxes, conduit, and sleeves to support the low voltage systems.
- C. The Electrical Contractor shall be responsible for coordinating installation with existing conditions and other trades on the job to insure pathways are not impeding other systems.

1.7 ACTION SUBMITTALS

- A. Product Data
 - 1. Provide manufacturer's catalog information showing dimensions, colors, and configurations.
 - 2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
 - a. Continuous and non-continuous cable pathway and fittings
 - b. All boxes and enclosures.
- B. Shop Drawings:

1. For custom enclosures and boxes. Include plans, elevations, sections, and attachment details.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and installation supervisor.
- B. Source quality-control reports.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Low Voltage Contractor must have personnel certified by the manufacturer on staff.
 1. Installation Supervision: Installation shall be under the direct supervision of Competent Technician, who shall be present at all times when Work of this Section is performed at Project site.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-B and BICSI's Telecommunications Distribution Methods Manual.

1.10 COORDINATION WITH OTHER TRADES

- A. Coordinate the cable pathways support systems as to not interfere with other building systems.
- B. Coordinate routing of cable pathways with the work of other trades to maintain adequate working clearances above, below and to the sides of cable pathways.

PART 2 - PRODUCTS

2.1 NON-CONTINUOUS CABLE SUPPORT (J-HOOKS)

- A. Acceptable Manufacturers
 - a. Cooper B-Line
 - b. Erico
 - c. Chatsworth Products, Inc.
 - d. Panduit
- B. General
 1. J-hooks shall have flared edges to prevent damage while installing cables.

2. J-hooks shall have an plastic, electro-galvanized or G 60 finish and shall be rated for indoor use for non-corrosive environments.
3. J-hook cable supports shall provide a bearing surface of sufficient width to comply with the bend radii of high performance cables.
4. J-hooks shall have a stainless steel cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.

C. Size

1. J-Hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high performance cables. J-hooks shall have a minimum bearing surface of 1 ¾ inches.
2. J-hooks shall have flared edges or be of a design as to relieve stress on cables at the bottom of the bundle that could impinge on the cables performance.
3. Follow Manufactures recommendations for allowable fill capacity for each size J-hook cable support. Typically fill capacity for a Caddy CAT32 type J-hook is 80 Cat 5 cables or 50 Cat 6 cables.

D. Support

1. J-hooks may be mounted to studs and stud walls. When mounting j-hooks to stud walls the j-hook shall be connected directly to the stud, the j-hook shall not be supported by the wall covering/ finish alone.
2. J-hooks may be supported by threaded rod. Refer to manufacturer's suggested attachment method to attach J-hook to threaded rod using standard nuts.
3. J-hooks may be supported by the use of beam attachments either factory or jobsite assembled either hammer or screw on type, C & Z perlin support, wall, concrete or joist support using factory approved attachment method.

- E. Installation: Provide dedicated space surrounding the non-continuous cable pathways to permit access for installing and maintaining cables. Refer to Section 3.2 below for specific clearances required.

2.2 WIRE BASKET SUPPORT SYSTEM

A. Acceptable Manufacturers

1. Cooper B-Line Flextray
2. Legrand Cablofil
3. Chatsworth Products, Inc.
4. WBT, LLC

5. Siemon

B. General

1. Provide wire basket of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates and splice bars. Construct units with rounded edges and smooth surfaces and in compliance with applicable standards.
2. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
3. Bond every section of cable tray to the adjoining tray as per manufacturer's specifications. Ground cable tray at end of every run.
4. Provide cable drop out brackets at every location where cable exits the tray.
5. Material and finish specifications for each wire basket type are:
 - a. Electroplated Zinc: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electroplated zinc in accordance with ASTB B633 SC2.

C. Size

1. Wire basket shall conform to the following nominal criteria:
 - a. Wire Basket Support System shall be constructed of a minimum of 0.195" [5mm] steel wire.
 - b. Mesh construction: 2 x 4 inches.
 - c. Straight section lengths of standard 8' and 10'.
 - d. Wire basket shall have standard depth of 4 inches.
 - e. Wire basket shall have standard widths of 4, 6, 8, 10, 12, and 18 inches.
 - f. Fittings shall be field formed or factory fittings.
 - g. All section splices shall be made per manufacturer's standards.

D. Support

1. Wire basket supports shall be trapeze hangers or wall brackets.
2. Trapeze hangers shall be supported by 1/4 inch or 3/8 inch diameter rods.

3. Special accessories shall be furnished as required to protect, support and install a complete wire basket support system.
4. Center hung supports shall not be allowed as wire basket tray support.

E. Installation

1. Install wire basket as indicated in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical practices.
2. Coordinate wire basket with existing conditions as necessary to properly interface installation of wire basket raceway with other work.
3. Provide dedicated space encompassing the wire basket to permit access for installing and maintaining cables. Refer to Section 3.2 below for specific clearances required.
4. Test wire basket support system to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test method.
5. The cross sectional area of the cables may not exceed 40% of the cross sectional area of the tray

2.3 LADDER RACK SUPPORT SYSTEM

A. Acceptable Manufacturers

1. Chatsworth Products
2. Cooper B-line
3. Panduit

B. General

1. Provide metal; cable trays, of types, classes, and size indicated; with splice plates, bolts, nuts and washers for connecting sections. Construct system maintaining rounded edges and smooth surfaces in compliance with the applicable standards. Cable tray shall be installed according to the latest revision of NEMA VE-2.
2. Ladder tray shall consist of two longitudinal members (side rails) with transverse members (rungs) welded or mechanically fastened to the side rails.
3. Straight sections, fitting side rails, rungs and splice plates shall be extruded from aluminum (ASTM B 221 6063 alloy) or shall have stringers made of 16 gauge hot

rolled steel tubing and cross members shall be made of 12 gauge cold rolled steel (ASTM A 569).

4. The cable raceway shall be available in black and gray painted finishes and clear anodized aluminum finish.
5. Ground cable rack at end of every run.
6. Bond every section of cable rack to the adjoining section as per manufacturer's specification.
7. Provide cable drop out brackets at every location where cable exits the tray.
8. Provide plastic end caps on side rails ends.

C. Size

1. Ladder rack shall consist of two side rails with transverse rungs welded, or mechanically fastened to the side rails. Rungs shall be spaced at 12 inches on center and shall have a minimum width of 1" for cable laying.
2. Straight sections shall be supplied in standard 10 foot lengths.
3. Ladder Rack shall be available in 6, 9, 12, 18 and 24 inch widths (as indicated on the drawings).
4. All fittings shall have a minimum bend radius of 12 inches
5. All section splices shall be made per manufacturer's standards.

D. Support

1. The cable raceway shall be supported by the side rails or trapeze support by a minimum 3/8 inch threaded rod and at intervals of no more than 5'.
2. Special accessories shall be furnished as required to protect support and install a complete ladder rack support system.
3. The cable raceway shall be capable of supporting 115 lb/ft when supported at 5' intervals.
4. The manufacturer shall provide hardware for joining sections of cable raceway in straight lines and at right angles. There shall also be hardware provided to mount and join the cable raceway in various configurations and attachment methods to walls, racks, and equipment.

E. Installation

1. Install ladder rack as indicated on drawings. Installation shall be in accordance with equipment manufacturer's instruction, and with recognized industry practices

to ensure that ladder rack complies with requirements of NEC and applicable portions of NFPA 70B Reference NEMA-VE2 for general ladder rack installation guidelines.

2. Coordinate ladder rack installation with other electrical work as necessary to properly integrate installation with other work.
3. Provide dedicated space encompassing the ladder racking to permit access for installing and maintaining cables. Refer to Section 3.2 below for specific clearances required.
4. Ladder rack fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instruction.
5. Test ladder rack to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.

2.4 BOXES AND ENCLOSURES

A. Acceptable Manufacturers:

1. Panduit
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. Hoffman; a Pentair company.
4. Hubbell Incorporated; Killark Division.
5. RACO; a Hubbell company.
6. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with ANSI/TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Boxes: Comply with NEMA OS 1 and UL 514A.

D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- F. Typical Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep (119 mm square by 60 mm deep), unless otherwise noted.
- G. Gangable boxes are prohibited.
- H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- I. Enclosures:
 - 1. Comply with UL 50 and NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 3. Nonmetallic Enclosures:
 - a. Material: Plastic.
 - b. Finished inside with radio-frequency-resistant paint.
 - 4. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
 - 5. Metal barriers to separate wiring of different systems and voltage.
 - 6. Accessory feet where required for freestanding equipment.
 - 7. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 FLEXIBLE RACEWAY (INNERDUCT)

- A. Acceptable Manufacturers
 - 1. Panduit
 - 2. CANTEX Inc
 - 3. Lamson & Sessions; Carlon Electrical Products.
 - 4. Lamson & Sessions: Pyramid Industries.
 - 5. RACO; a Hubbell company.
 - 6. Thomas & Betts Corporation.
- B. Flexible Raceway shall be plenum rated.
- C. Flexible raceway shall meet the requirements:

1. NEC Articles 770 and 800 for Telecommunications Cables.
 2. Flexible raceway shall be UL Listed under UL 910 Standard for Plenum Application for Optical Fiber Raceway.
- D. Flexible raceway shall be provided with a pull (mule) tape routed throughout the raceway containing footage markings.
- E. Flexible raceway fitting and accessories shall be manufactured by the same manufacturer as the flexible raceway.

2.6 CONDUITS/SLEEVES

A. General

1. Conduit/sleeve shall be EMT grade metallic conduit schedule 5 or heavier.
2. Any conduit/sleeve installed for communication cabling shall have a coupler on each end with a plastic bushing for cable protection.
3. Terminate metal conduit using connectors with plastic bushings.
4. Provide nylon or plastic pull strings in all conduit runs.

B. Fire Wall Penetrations

1. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
2. Fire stop penetrations seal methods and materials shall be FM-approved and UL listed as applicable and as approved by the authorities having jurisdiction.
3. All sealing methods shall be submitted to the engineer of record for review prior to sealing.

2.7 NONMETALLIC RACEWAY

A. Acceptable Manufacturers

1. Legrand-Wiremold Eclipse PN05 Series, Classroom
2. Panduit LDPH5 Series, Classroom
3. Legrand Wiremold 5500, 6" Raceway, Main Pathways
4. Legrand Wiremold 5040, 4" Raceway, Main Pathways

- 5. Hubbell PB2 and PS2, Main Pathways
- 6. Hubbell PW1, Classroom
- B. Flexible Raceway shall be fog white or off white in color.
- C. Non-metallic raceway shall meet the requirements:
 - 1. NEC Articles 770 and 800 for Telecommunications Cables.
 - 2. Raceway shall be UL Listed under UL 910 Standard for Plenum Application for Optical Fiber Raceway.
- D. Flexible raceway shall be provided with a pull (mule) tape routed throughout the raceway containing footage markings.
- E. All raceway fitting and accessories shall be manufactured by the same manufacturer as the non-metallic raceway.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pathways shall primarily be constructed from wall/structure mounted J-hooks, J-hooks hung from ceiling, Ring type supports, wire basket trays supported by threaded rod or wall brackets, ladder rack supported by threaded rod or wall brackets, or conduit supported as per the NEC.
- B. J-hooks shall not be attached to the any drop ceiling grid wiring.
- C. In finished areas, conceal conduits and flush mount boxes.
- D. Conduit installation shall be coordinated with their respective termination equipment layouts at each backboard location as required to provide adequate dedicated space for equipment provided and installed by the Electrical Contractor .
- E. Cable pathway systems shall be supported by support systems specifically designed and manufactured for the support of cable pathway systems. The cable pathway systems shall not be supported by other installed building systems.
- F. Install all pathway systems as per manufacturers recommended practices and as per local Owneral regulations and NEC, and BICSI regulations and practices.
- G. All cable pathway routes are to be parallel and/or perpendicular with the outside walls of the building. Alternate paths must be approved by the engineer of record prior to installation of the cabling.
- H. Grounding and Bonding

1. Wire basket tray shall be bonded directly to the TMGB or TGB in the telecommunications equipment room that the wire basket tray supports.
 2. Provide and install a grounding conductor routed through the entire run of all wire basket tray. The grounding conductor shall be bonded to each individual piece of cable basket tray.
 - a. Any splices in the grounding conductor shall be protected, readably visible and accessible upon completion of the cable installation.
 - b. Refer to specification section "Grounding and Bonding for Communication Systems" for grounding conductor requirements and sizing.
 3. Ladder rack shall be bonded directly to the TMGB or TGB within the telecommunications equipment room the ladder rack is located.
 4. Provide a bonding jumper connecting each rail of each piece of ladder rack to one another to form a continuous grounding path.
- I. Cable pathways
1. A dedicated pathway shall be provided for each low voltage communications cabling sub-system, including but not limited to the structured cabling system, security systems, audio/visual systems and other low voltage control system cabling.
- J. Non-Continuous Cable Pathways (J-Hooks/Rings)
1. Non-continuous cable support shall be located at intervals of four (4) feet maximum.
 2. Non-continuous cable supports shall be installed such that all cable runs through them maintain a minimum clearance of 12-inches in relation to all fluorescent lights and EMF sources. Any violations of this rule will be corrected at the contractor's Expense.
 3. Horizontal cabling shall not lay on any ceiling or ceiling tile. All horizontal cabling shall maintain a minimum clearance of 6" above ceiling, ceiling tile and support channels.
 4. Cable pathways shall not be routed parallel with electrical conduits or strapped to or supported by any electrical conduits or any other building service equipment.
- K. Conduit/ Sleeves
1. Any section of conduit longer than 150 feet or containing more than a total 180 degrees of bends shall have pull boxes. These boxes will not be shown on drawings. Refer to the table below for pull box sizing.

2. Each conduit bend shall be a long sweep radius wherever possible. In no instance shall the inside radius or bend be less than six (6) times the internal diameter of the conduit for conduits that are 2" in diameter or less, for conduits larger than 2" the bend radius shall be no less than 10 (ten) times the inside diameter.
3. All sleeves shall be of a size as to not have more than 40% of the sleeve filled with low voltage cable at the completion of the installation. Provide a minimum of 50% capacity for future growth at each sleeve location.
4. In locations containing multiple sleeves, sleeves shall be filled to capacity before installing cabling in adjacent sleeves.
5. All conduits/sleeves shall be secured and strapped to building surfaces per National Electric Code (NEC 2008 Article 358.30 (A) and (B)).

L. Pull Boxes

1. Install pull boxes where required to maintain minimum bend radius at wall/pathway transitions.
2. All pull boxes installed in low voltage communications conduit runs shall be sized per NEC or Table 4.7 of the BICSI Telecommunications Distribution Methods Manual, whichever requirement results in a larger pull box.
3. Provide dedicated space encompassing pull box to permit access for installing and maintaining cables. Refer to Section 3.2 below for specific clearances required.

M. Firestopping

1. Comply with requirements in Division 07 Section "Penetration Firestopping" and ANSI/TIA-569-B.
2. Responsibility for sealing of opening around the exterior of the low voltage system sleeves shall be by the contractor as described below:
 - a. Sleeves through fire rated and smoke walls created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
 - b. Sleeves through fire rated and smoke walls created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
 - c. Sleeves of openings between floors created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.

- d. Sleeves of openings between floors created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
 - 3. Sealing of the space internal to all sleeves or openings specifically designated for telecommunications cabling shall be the responsibility of the Low Voltage Contractor.
 - 4. Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over this work.
- N. Separation from EMI Sources:
- 1. Comply with BICSI TDM and ANSI/TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
 - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
 - 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

- b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.2 CLEARANCES AROUND CABLE PATHWAYS

- A. Clearances shall be provided around all cable pathways to provide continuous access to the cable pathway during and following the installation process. Coordinate required clearances with all other trades prior to beginning work.
- B. Provide a minimum clearance of 8" above the entire width of all cable basket tray and ladder tray.
- C. Provide a minimum clearance of 12" to one side of all cable basket tray and ladder tray.
- D. Provide a minimum clearance of 12" in front of all J-hook cable pathways for the entire height of the j-hook cable pathway.
- E. Provide a minimum clearance of 6" above all J-hook cable pathways.
- F. Provide a minimum clearance of 24" in front of each pull box location.

END SECTION 27 05 28

DIVISION 27 – TELECOMMUNICATIONS
SECTION 27 11 00
COMMUNICATIONS ROOM FITTINGS

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. Backboards.
 - 2. Telecommunications Equipment Racks and Cabinets.
 - 3. Equipment Rack and Cabinet Accessories.
- B. Related Requirements:
 - 1. Division 27 Section "Pathways for Communications Systems" for cable trays and accessories.
 - 2. Division 27 Section "Grounding and Bonding for Communications Systems" for grounding and bonding of equipment room fittings.
 - 3. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
 - 4. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.
- C. LAN: Local area network.

1.4 RESPONSIBILITIES

- A. The term Electrical Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives used in this specification document to produce the finished product as described here-in.
- B. The Electrical Contractor shall be responsible for providing all equipment, backboards, equipment racks and cabinets, mounting hardware, associated equipment within each equipment rack and cabinet and associated support, splices, terminating hardware, etc.

as necessary to provide a functional equipment mounting system for the communications equipment.

- C. The Electrical Contractor shall be responsible for coordinating installation with general contractor and other trades on the job to insure pathways are not impeding other system installations.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and installation supervisor.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Low Voltage Contractor must have personnel certified by the manufacturer on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of Certified Technician, who shall be present at all times when Work of this Section is performed at Project site.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-B and BICSI's Telecommunications Distribution Methods Manual.
- D. Grounding: Comply with ANSI-J-STD-607-A.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames, power strips and other communications room equipment until spaces are enclosed and weather tight, wet work in spaces is complete and dry.

1.9 COORDINATION

- 1. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of UPS and LAN equipment.
 - 2. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate with the electrical contractor.

PART 2 - PRODUCTS

2.1 BACKBOARDS

- A. Backboards:
 - 1. The plywood backboard shall be painted with two coats of fire retardant paint covering the face and all of the edges of the plywood backboard.

2.2 POWER STRIPS

- A. Acceptable Manufacturers:
 - 1. APC, by Schnieder Electric
 - 2. Chatsworth Products, Inc. (CPI)
 - 3. Geist Manufacturing
 - 4. Server Technology, Inc.
- B. Power Strips: Comply with UL 1363.
 - 1. Both horizontal rack mounted and vertical offset mounted power strips shall include the required mounting hardware.
 - 2. Power strips mounted in wall mounted equipment cabinets shall be mounted internally to the cabinet and include the required mounting hardware.
 - 3. Power strips shall be available from distribution stock with standard NEMA style receptacles including: 5-20R, L5-20R, L5-30R, C-13 and C-19 receptacles.

4. Power strips shall be available with close-coupled, direct plug-in, cord connected with 15-foot or hard wired line cords. Direct plug-in line cords shall be available with NEMA standard plugs including 5-20P, L5-20P and L5-30P.
5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and can be reset.
6. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
7. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.
8. Power strips shall be capable of monitoring the voltage, amperage, wattage and power factor of the power strip. Values shall be displayed on the face on the face of the power strip.

2.3 EQUIPMENT FRAMES

A. Wall Mounted Equipment Rack

1. Approved Manufacturers:
 - a. Chatsworth Products, Inc. (CPI) Standard Swing Gate Wall Racks
 - b. Great Lakes Cabinets SR Wall Mount Swing Racks
 - c. Cooper B-Line Swing Gate Racks
 - d. Belden XWR Series
 - e. Hoffman SWM Series
2. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA-568-B.
3. Wall-mounted racks shall be manufactured from sheet aluminum and/or steel and aluminum extrusion.
4. The rack will consist of a wall-mount frame and a swing gate. The swing gate will support 19" EIA wide equipment, and will pivot open to provide easy access to the back of equipment.
5. The swing gate will be connected to the wall-mount frame on both sides at the top and the bottom of the swing gate with spring loaded hinge pins. The swing gate will pivot open to 90°. Spring-loaded hinge pins will allow the rack to open from the right or from the left.
6. The swing gate will be secured in the closed position by the spring-loaded pins. Cast corner ramps on the wall-mount frame will lift the pins during the closing motion so that the rack can be shut with one hand. The pins will latch with an audible click. To open the swing gate, both the top and bottom pins opposite the hinged side must be operated simultaneously.

7. The rack will be EIA-310-D compliant. Rack-mount spaces/units (RMU) will be 1-3/4" high. The swing gate will have a single pair of C-shaped equipment mounting rails. The front and back of the mounting rails will be punched with the Universal hole pattern. Mounting holes will be spaced vertically on alternating 5/8"-5/8"-1/2" centers and will be roll-formed with #12-24 threads. Mounting rails will provide rack-mount spaces (RMU) for equipment as specified on project drawings.
8. The rack will be a minimum of 18" deep.
9. The rack will be rated to support 100 pounds of equipment. Load bearing capacity will be certified and UL Listed using NWIN and UL Standard 60950. UL Listing will be stated in the manufacturer's product literature. The manufacturer will sell a heavy-duty bracing kit that will increase the load of the rack to 150 pounds of equipment when used.
10. Finish shall be clear brushed/grained aluminum or epoxy-polyester hybrid powder coat (paint) in black as specified on project drawings.
11. Each rack will include 50 each #12-24 equipment mounting screws and installation hardware (1/4" x 2" hex lag screws for wood stud walls).
12. The equipment rack shall be EIA-310-D compliant with the Universal hole pattern. Rack-mount spaces/units (RMU) will be 1-3/4" high. Mounting holes will be spaced vertically on an alternating 5/8"-5/8"-1/2" centers and will be roll-formed with #12-24 threads. Shall be UL listed.

2.4 LABELING

- A. Comply with ANSI/TIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- D. Cable Management
 1. Provide vertical cable management between each equipment rack and at the end of each row of racks. Refer to the plans for exact vertical cable management quantities, locations and sizes.
 2. Waterfall cable management shall be provided at the top of each equipment rack to support cables entering the rack channels from cable pathways above for protection and to maintain proper bend radius and cable support.

3. Horizontal wire management shall be mounted above and below each group of patch panels on the rack. The horizontal wire management shall be one rack-unit (RU), refer to project plans for exact size and description.
 4. Each equipment rack/cabinet shall include mounting brackets for cable tray ladder rack to mount to the top of the rack as required. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable.
- E. Free standing floor mounted equipment racks/ cabinets/ enclosures shall be mounted such that a minimum of 3'-0" is provided between the equipment rack/ cabinet/ enclosure and the wall or piece of equipment immediately in front of it for working space. In the case of free standing two-post equipment racks, 1'-6" shall be allocated for the depth of equipment, beginning at the face of the equipment rack.
 - F. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 GROUNDING

- A. Comply with ANSI-J-STD-607-A.
- B. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.3 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration including optional identification requirements of this standard.
- C. Labels shall be preprinted or computer-printed type.

END SECTION 27 11 00

DIVISION 27 – TELECOMMUNICATIONS
SECTION 27 13 00
COMMUNICATIONS BACKBONE CABLING

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. Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality, general configuration, and operating characteristics desired only. This specification is intended to be a minimum standard for function, operation and performance. Equipment catalog numbers are listed to establish this minimum.
- B. Section Includes:
 - 1. 50/125-micrometer multi mode optical fiber cabling.
 - 2. Cable connecting hardware, patch panels, and cross-connects.
 - 3. Cabling identification products.
- C. Related Requirements:
 - 1. Division 27 Section "Grounding and Bonding for Communications Systems" for grounding and bonding of equipment room fittings.
 - 2. Division 27 Section "Pathways for Communications Systems" for cable trays and accessories.
 - 3. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 SUMMARY OF WORK

- A. Furnish and install complete with all accessories a communication backbone cable system. The backbone cable shall serve as a vehicle for transport of data, video and voice telephony signals throughout the network between designated demarcation points and other locations as indicated on the contract drawings and described herein.
- B. Cabling utilized for data and voice communications shall terminate in either wall mounted termination blocks, cabinets, or panels, in vertical free standing equipment racks, and/or enclosed equipment racks located at the Telecommunications Equipment Room (ER) and/or the Telecommunications Room (TR) location(s).
- C. The communications backbone cabling system shall utilize a network of optical fiber riser and tie cables. Cables and terminations shall be provided and located as shown and in the quantities indicated on the drawings.

1. Fiber cables shall terminate on fiber patch panels located at demarcation and termination points shown on the drawings.
 2. All cables and terminations shall be identified and labeled per project drawings and owner specifications at all locations. Additionally, all existing terminations shall be labeled.
 3. All cables shall terminate in an alpha-numeric sequence at all termination locations.
- D. All optical fiber cable and terminations shall comply with their rated performance and standard and be tested per the requirements of this document.
- E. All new 50um multimode and 9um singlemode fibers between the ER (MDF) and TR (s) (IDF) shall be terminated, tested and shall be identified at each location on aqua LC Fiber Adapter Panels.

1.4 REFERENCES

- A. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
- B. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Wiring Standards, General requirements.
- C. ANSI/TIA-568-C.2 - Commercial Building Telecommunications Wiring Standards, Balanced Twisted Pair Cabling Components.
- D. ANSI/TIA-568-C.3 - Commercial Building Telecommunications Wiring Standards, Optical Fiber Cabling Components standards.
- E. ANSI/TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces.
- F. ANSI/TIA-606-A – Administration Standards for Commercial Telecommunications Infrastructures.
- G. ANSI/TIA-758-A – Customer Owned Outside Plant Telecommunications Infrastructure.
- H. ANSI J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- I. International Standards Organization/International Electrotechnical Commission (ISO/IEC) 11801.
- J. Underwriters Laboratories (UL®) Cable Certification and Follow up Program.
- K. National Electrical Manufacturers Association (NEMA).
- L. American Society for Testing Materials (ASTM).
- M. National Electric Code (NEC®) 2014
- N. Institute of Electrical and Electronic Engineers (IEEE).
- O. UL Testing Bulletin.

- P. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps.
- Q. BICSI – TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM), most recent version.
- R. BICSI – Outside Plant Design Manual, most recent version.

1.5 RESPONSIBILITY

- A. The term Electrical Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

1.6 DEFINITIONS

- A. Backbone cabling System: A Communication Backbone Cabling System is defined as all required equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, and fiber optic cable installed and configured to provide computer data and voice connectivity between entrance facilities, equipment rooms, main distribution frames, and intermediate distribution frames with the network file server or voice network/switch designated as the service point of the local area network.
- B. Riser Backbone: The Riser Backbone subsystem links the equipment room (ER) and telecommunications rooms (TR). The riser backbone consists of the transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology.
- C. Campus Backbone: A Campus Backbone is used when a distribution system encompasses more than one building. The components and cables that provide the link between buildings constitute the Campus Backbone. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or power surges. It is normally first-level backbone cables beginning in the equipment room of the hub building and extending to the equipment room of a satellite building.
- D. Equipment Subsystem: The Equipment Subsystem consists of shared (common) electronic communications equipment in the equipment room, or telecommunications closet and the transmission media required to terminate this equipment on the distribution hardware.
- E. The Administration Subsystem: The Administration Subsystem links all of the subsystems together. It consists of labeling hardware for providing circuit identification and patch cords or jumper wire used for creating circuit connections at the cross connects.
- F. BICSI: Building Industry Consulting Service International.
- G. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- H. EMI: Electromagnetic interference.
- I. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.

- J. IDC: Insulation displacement connector.
- K. LAN: Local area network.
- L. RCDD: Registered Communications Distribution Designer.
- M. UTP: Unshielded twisted pair.

1.7 ACTION SUBMITTALS

A. Material Provided

- 1. The successful Electrical Contractor shall be certain that all correct parts are ordered per Products Section of this document and installed in accordance with manufacturers design and installation guidelines. Electrical Contractor shall submit complete parts list and part numbers to Engineer prior to installation of equipment for approval.

B. Product Data:

- 1. Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- 2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
 - a. All optical fiber and copper cable and cross connect wire.
 - b. All connectors and required tooling.
 - c. All termination system components for each cable type.
 - d. All grounding and building entrance protection surge suppression system components.
 - e. All test equipment to be used for fiber and copper cable test.
- 3. Technical data sheets shall include the physical specifications as well as the following transmission characteristics for the optical fiber cable:
 - a. Maximum Attenuation
 - b. Minimum LED Bandwidth
 - c. Minimum Effective Modal Bandwidth

C. Shop Drawings:

- 1. System Labeling Schedules: Electronic copy of labeling schedules, in MS Excel software format and any additional format selected by Owner.
- 2. Cabling administration drawings and printouts.
- 3. Wiring diagrams to show typical wiring schematics including the following:

- a. Cross-connects.
 - b. Patch panels.
- 4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- D. Pre-Qualification Certificate: Electrical Contractor shall submit the following documents with project proposal:
 - 1. A letter of approval from the manufacturer indicating completion of pre-qualification requirements by installing vendor.
 - 2. Submit proof from manufacturer of Electrical Contractor's good standing in the cabling manufacturer's qualification program.
 - 3. Submit training certificates for design, engineering and installation of the proposed products awarded to the Electrical Contractor's assigned project manager and installers. (Only installers with manufacturer's certificate of competency in installing the proposed SCS will be acceptable for this project).
- E. Warranty Documentation
 - 1. Complete documentation regarding the manufacturer's Extended Product Warranty and Application Assurance Program shall be submitted. This shall include, but is not limited to: a sample of the warranty that will be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues and guaranteed performance information.
 - 2. A systems application assurance manual documenting the vendor supported applications and application guidelines shall be provided as part of the submittals.

1.8 INFORMATIONAL SUBMITTALS

- A. Personnel/ Installer Qualifications: Submit credential and qualification information for each of the following individuals:
 - 1. Installation Supervisor
 - 2. Field Inspector
- B. Manufacturer and on-site delivery test results for all optical fiber cabling.
- C. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.9 CLOSEOUT SUBMITTALS

- A. As-Built Drawings/Documentation as specified in Section 3.3R.
- B. Test Results: Test results shall be submitted in both PDF form and in the native electronic file format of the test equipment.
 - 1. As specified in Section 3.5.

- a. Optical Fiber Test Results
2. Test equipment firmware and software versions.
3. Test equipment proof of calibration documentation.

1.10 QUALIFICATIONS

- A. The Electrical Contractor selected to provide the installation of this system shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein.
- B. The Electrical Contractor shall utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- C. The Electrical Contractor and design firm shall be in compliance with all federal, state and local statutes regarding qualifications of firms.
- D. The Electrical Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
- E. The Electrical Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and metallic premise distribution systems.
- F. The Electrical Contractor shall have personnel who are adequately trained in the usage of such tools and equipment.

1.11 QUALITY ASSURANCE

- A. The Electrical Contractor shall guarantee that all twisted pair copper and fiber optic cabling, cable pathways and associated components meet or exceed specifications (including installation) of ANSI/TIA/EIA-568-C.1, 568-C.2, 568-C.3 and 569-B.
- B. Installer Qualifications: Low Voltage Contractor must have personnel certified by the manufacturer on staff.
 1. Installation Supervision: Installation shall be under the direct supervision of Competent Technician, who shall be present at all times when Work of this Section is performed at Project site.
- C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Grounding: Comply with ANSI-J-STD-607-A.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Test all cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight.
 - 2. Test optical fiber cable while on reels.
 - 3. Visually inspect all cable upon delivery for damage during transport.
 - 4. Store cables in dry areas that are free of potential pre-installation damage.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PRODUCT WARRANTY AND APPLICATION ASSURANCE

- A. The Structured Cabling System (SCS) shall be provided with an Extended Product Warranty and Application Assurance Program guaranteeing performance and operation of the SCS (including optical fiber and copper cabling).
- B. Extended Product Warranty
 - 1. The Extended Product Warranty covers product defects for all passive components of the SCS. Passive components are defined as those exhibiting no gain or contributing no energy. The manufacturer shall warrant, from the date a Registration Certificate is issued by the manufacturer to the end-user, the following:
 - 2. The passive products that comprise the registered SCS will be free from manufacturing defects in material or workmanship under normal and proper use.
 - 3. All SCS approved passive cabling products that comprise the registered SCS solution exceed the specification of ANSI/TIA-568-C.1, ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3 standards and will conform to the guaranteed minimum performance specifications published within the manufacturer's associated product data sheet and warranty platform documentation in effect at the time the Registration Certificate is issued for the duration of the extended warranty period.
- C. Term of Warranty
 - 1. The Extended Product and Application Assurance Warranty shall span minimum 20 years from the date of issuance of the Registration Certificate or completion of installation, whichever is later.
 - 2. The warranty shall be for the benefit of the person or entity to which the manufacturer's SCS Registration Certificate is issued and any successor in interest to the site in which such System was originally installed by the manufacturer or an Authorized manufacturer's Reseller.

3. If the manufacturer repairs the product, the repair shall utilize only new replacement parts. Replacement of existing parts shall be with new parts of the same design meeting or exceeding the performance of the replaced parts. Any such repair or replacement shall include a warranty for either 90 days or the remainder of the original warranty period, whichever is longer.

2.2 OPTICAL FIBER CABLING

A. General

1. The cable must meet the requirements of the National Electric Code (NEC) Section 770.
2. Plenum Applications - Applicable Flame Test: UL 910 (NFPA 262-1994)

B. Optical Fiber Characteristics

1. Acceptable Manufacturers
 - a. Corning
 - b. OFS
 - c. Panduit
 - d. Superior Essex
 - e. Systimax
 - f. Berk-Tek
 - g. Belden
2. All fibers must be useable and meet the required specifications. All optical glass shall be manufactured in the US by Corning Optical Fiber Products or OFS.
3. All fiber cables must be flame retardant and meet UL-1666 OFNR specification
4. All optical fibers shall be sufficiently free of surface imperfections and occlusions to meet the optical, mechanical, and environmental requirements of this specification
5. A silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD).
6. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m²). The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
7. The attenuation specification shall be a maximum value for each cabled fiber at $23 \pm 5^{\circ}\text{C}$ on the original shipping reel.

8. Multi-mode optical fiber cable shall be available in standard strand quantities of: 6, 12, 24, and 48 counts.
 9. The cable shall be reinforced with Aramid yarn for superior strength.
 10. All plenum-rated cable shall meet or exceed the requirements of NFPA-262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces, and are OFNP Listed with Underwriters Laboratory.
 11. All loose-tube constructed optical fiber cable shall meet the following requirements:
 - a. The cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
 - b. The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.
 - c. The cable core shall be water blocked without the use of flooding compounds.
- C. Indoor/ Outdoor Riser-Rated Loose Buffered Optical Fiber Cable.
1. Fiber bundles wrapped in water swellable yarns within loose tubes.
 2. Water swellable yarns routed between and surrounding the separate tubes
 3. Color-coded fibers and buffer tubes.
 4. Ripcord
 5. Dielectric strength members all surrounded in a UV-resistant/flame-retardant outer jacket.
 6. All-dielectric construction.
 7. Flexible buffer tubes.
 8. UL-listed OFNR (UL1600) and CSA-listed FT-4.
- D. Indoor/ Outdoor Plenum-Rated Tight Buffered Optical Fiber Cable.
1. The cable shall be a totally dry tight buffered water-proof central core cable.
 2. The cable shall not contain any gel, filling or flooding compound, grease or other flammable water blocking fluids.
 3. The cable shall use aramid yarns for strength in conjunction with a glass reinforced polyemer (GRP) central strength member (CSM).
 4. The aramid yarns shall specially prepared with an agent that shall provide the water-proof attribute of the cable.
 5. The plenum-rated indoor/outdoor cable shall meet all Bellcore GR-409 requirements.

6. The plenum-rated indoor/outdoor cable shall meet or exceed the requirements of NFPA-262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces, and are OFNP Listed with Underwriters Laboratory.
 7. All cables must meet the mechanical and environmental requirements of Telcordia GR-20-CORE Issue 2 Generic Requirements for Optical Fiber and Optical Fiber Cable and ANSI/ICEA S-87-640 Standard for Optical Fiber Outside Plant Communications Cable.
- E. Optical Fiber Outside Plant (OSP) Cable
1. This cable is designed to connect equipment or facilities that are separated by an outdoor type environment.
 2. It shall be suitable for underground, aerial, direct buried, tunnel, or tray installations.
 3. Outside plant cabling shall be of loose tube construction.
 4. The cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
 5. The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.
 6. The cable core shall be water blocked without the use of flooding compounds.
 7. The cable shall be designed for point-to-point applications as well as midspan access, provide a high-level of protection for fiber installed in the outside plant environment.
- F. Packing and Shipping
1. The cable shall be packaged in cartons and/ or wound on spools or reels. Each package shall contain only one continuous length of cable with sufficient length for entire run without splicing. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.
 2. Tests tails shall be at least 2 meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Tails shall be permanently marked with an identification number that it can be used by the manufacturer to trace the manufacturing history of the cable and the fiber.

2.3 MULTI-MODE OPTICAL FIBER

- A. Multimode optical fiber shall meet the OM3 Laser Optimized 50-Micron Multi-Mode Optical Fiber Cable (10Gb/s @ 300m) standards for performance.
- B. Multimode fiber shall meet the following standards:
1. EIA/TIA-492AAAD, "Detail Specification for 850-nm Laser-Optimized 50- μ m Core Diameter/125- μ m Cladding Diameter Class 1a, Graded-Index Multimode Optical Fibers."

2. ISO/IEC 11801 type OM3 fiber
 3. IEC 60793-2-10 type A1a.3 fiber
- C. Laser 50-Micron Optical Fiber Cable shall have the same specified performance as 50-Micron Optical Fiber Cable specified above except the following performance and geometry values.
- D. The maximum cabled fiber attenuation shall be $\leq 2.5\text{dB/km}$ at 850 nm and $\leq 1.0\text{ dB/km}$ at 1300 nm.
- E. The cabled laser Effective Modal Bandwidth (EMB) shall be $\geq 4700\text{ MHz/km}$ at 850 nm and $\geq 500\text{ MHz/km}$ at 1310 nm.
- F. The minimum bandwidth during Overfilled Launch (OFL) conditions shall be $\geq 3500\text{ MHz/km}$ at 850 nm and $\geq 500\text{ MHz/km}$ at 1310 nm
- G. The optical fiber shall support the following applications at the associated distances:
1. 10 Gigabit Ethernet (802.3ae)
 - a. 850 nm serial laser (10GBASE-SR & 10GBASE-SW): 300m
 - b. 1310 nm CWDM lasers (10GBASE-LX4): 300m
 2. 1 Gigabit Ethernet
 - a. 850 nm serial laser (1000BASE-SX): 1040m
 - b. 1310 nm serial lasers (1000BASE-LX): 600m
 3. 100 Megabit Ethernet
 - a. 850 nm serial LED (100BASE-SX): 300m
 - b. 1310 nm serial LED (100BASE-FX): 2000m
 4. 10 Megabit Ethernet: 850 nm LED (10BASE-FL): 1250m
 5. 10 Gigabit Fibre Channel (10GFC Rev 3.0)
 - a. 850 nm serial laser (1200-M5E-SNS): 300m
 - b. 12010 nm WWDM lasers (1200-M5-LC3S): 300m
 6. 1 Gigabit Fibre Channel: 850 nm serial laser (100-Mx-SNI): 970m

2.4 OPTICAL FIBER CONNECTORS

- A. General Connector Requirements
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of ANSI/TIA-604 and appropriate sub sections. Comply with ANSI/TIA-568-C.3.

2. Multi-Mode fiber optic connectors shall be factory or field installed.
 3. Fiber optic connectors shall be quick-connect mechanical terminated connectors.
 4. Multi-Mode fiber optic connectors shall be duplex LC style connectors.
 5. Fiber connectors shall have < 0.2 dB change after 500 re-matings.
 6. The connector operating temperature shall be -40 to 167°F (-4 to 75°C).
 7. Connectors shall have a temperature stability (-4°C to +75°C) Insertion Loss Change of <0.1 dB.
- B. Acceptable Manufacturers
- a. Panduit Opticom, Basis of Design
 - 1) Panduit FLCDMCXAQY, Duplex LC, Aqua (50um)
 - 2) Panduit FLCSSCBUY, Duplex LC, Blue (9.0um)
 - b. Belden
 - c. Commscope
 - d. Siemon
- C. LC Optical Fiber Connectors
1. The connector shall be available for Singlemode OS2 and Multimode OM3 fiber optic cables.
 2. The connector shall utilize a phosphor bronze or zirconia ferrule for fiber alignment.
 3. The connector shall have push-pull hardware for easier connections, as well as high optical stability.
 4. The connector shall be duplex type, with two LC connectors in one module space.
 5. LC type connectors shall have an average loss of less than 0.1dB for multi-mode cabling.

2.5 OPTICAL FIBER HOUSINGS

- A. All optical fiber hardware shall be manufactured by the same manufacturer as the optical fiber cabling unless specified otherwise.
- B. General Optical Fiber Housing Requirements
1. Optical fiber housing shall be available for cross-connection or inter-connecting purposes. The units shall provide for direct connectorization and pigtail splicing. All connector housings shall meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0.

2. Each optical fiber housing shall accept a labeling scheme that complies with ANSI/TIA-606-A.
3. Each optical fiber housing shall include clamshell-type clamping mechanisms to provide cable strain relief. Each cable clamp shall accept one cable with an OD of 9.5 – 28.6 mm. Each cable clamp shall also handle multiple small fiber count cables when used with the multiple cables insert; these clamps shall have a capacity of five cables with an OD of ≤ 10.2 mm. Cable clamps shall be provided as required by the panel/ module loading of the connector housing.
4. Optical fiber housings shall be manufactured using 16 gauge aluminum or equivalent for structural integrity. Housings shall be finished with a wrinkled black powder coat for durability.

C. Connector Housings

1. Connector housings shall be mountable in an EIA-310 compatible 19" rack. Housing shall be of available in 1RU and 2RU, heights. Connector housing shall not exceed a depth of 12".
2. Connector housings shall be modular in nature with separate splicing, jumper management and combination connector/ splicing housings available.
3. Connector housings shall be available in 4 and 8 insert fiber adapter panel inserts shall be available in 6 and 12 connector panel configurations.
4. The connector housing shall include jumper/ patch cord routing guides to allow a transition and segregation point for cords exiting the front and back of the housing.
5. Feeder cable entries shall have a grommet installed to minimize dust/ water intrusion.
6. Connector housings doors shall have removable hinged front and rear doors.
7. Connector housings shall include provisions for mounting fiber fan-out devices and factory installed cable stubs for multiple cable and connector types.

2.6 CONNECTOR PANELS AND MODULES

A. Connector Panels

1. Connector panels shall be manufactured by the same manufacturer as the connector housing.
2. Connector panels shall utilize a single mounting footprint.
3. Connector panels shall be available in four, six, eight, and twelve connector adaptor configurations.
4. Connector panels shall be attached to the connector housing with a minimum of two push-pull style latches.

5. Connector panels shall be available in industry standard single fiber and small form factor multi-fiber adapters, including SC duplex, ST compatible, MTRJ and LC.
6. Blank panels shall be provided to fill each unused space within the housing.
7. Connector panels shall be manufactured from 16 gauge cold rolled steel or injection molded polycarbonate.

B. Connector Modules

1. The connector module shall be a modular removable case containing optical fiber connector adapters and provisions for strain-relief, slack storage, and the furcation of fiber optic cables.
2. Connector modules shall be manufactured by the same manufacturer as the connector housing.
3. Connector modules shall consist of a panel incorporated into a protective case with a removable cover for access to the interior connectors and fibers.
4. Connector modules shall include a fiber retaining spool for managing slack fiber.
5. Connector modules shall utilize a single mounting footprint.
6. Connector modules shall be available in three, four, six, eight, and twelve connector adaptor configurations.
7. Connector modules shall be attached to the connector housing with a minimum of two push-pull style latches.
8. Connector panels shall be available in industry standard single fiber and small form factor multi-fiber adapters, including SC duplex, ST compatible, MTRJ and LC type connectors.
9. Connector modules shall be manufactured from 16 gauge cold rolled steel or injection molded polycarbonate.
10. Connector modules shall be available in the following configurations: adapter modules, pigtail modules, and pre-terminated system modules.

C. Acceptable Manufacturers

- a. Panduit Opticom, Basis of Design
 - 1) Panduit FAP6WAQDLC, 6 Port Duplex LC, Aqua (50um)
 - 2) Panduit FAP6WEIDLC, 6 Port Duplex, Ivory (62.5um)
- b. Belden
- c. Commscope

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Components of the backbone cabling system shall be installed in a neat, workmanlike manner.
- B. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system.
- C. Identification markings and systems shall be uniform.
- D. The Electrical Contractor shall be responsible for damage to any surfaces or work disrupted as a result of his work. Repair of surfaces, including painting, shall be included as necessary.

3.2 ADMINISTRATION

- A. The administration subsystem shall consist of wiring blocks and or patch panels for termination of copper cables or optical fibers. All wall field layouts to be as detailed on drawings or as approved by Engineer prior to installation.
- B. Termination blocks: Termination blocks that require rotation after connection of horizontal/vertical wiring shall not be allowed.

3.3 INSTALLATION

- A. The Electrical Contractor shall ensure that all recommended cable pulling tensions and pulling bending radius are not exceeded. Any cable bent or kinked to a radius less than the recommended dimension shall not be installed. Any cable that is bent or kinked to a radius less than the recommended dimension during installation shall be replaced by the Electrical Contractor at no additional cost to the project.
- B. Throughout the project, the Electrical Contractor shall provide levels of manpower necessary to meet all construction schedules.
- C. The Electrical Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals and shop drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.
- D. All installation shall be done in conformance with ANSI/TIA 568-B standards, federal and local standards and the cable manufacturers Installation guidelines.
- E. The Electrical Contractor shall make provisions so that all cabling is stored within a temperature controlled space to ensure that cabling is unspooled, manipulated, and worked with only when the cabling is within the manufacturer's installation temperature specifications and free of condensation.
- F. Electrical Contractor shall terminate all wires and fibers.
- G. Campus Backbone
 - 1. The Electrical Contractor shall supply and install the transmission media and terminating hardware to provide inter-building communications facility.

2. All campus backbone cabling shall be installed with a minimum of 10'-0" of slack at each point of termination.
3. All maintenance holes (man holes, hand holes, etc.) shall be "wrapped" such that a cable entering one wall shall not immediately exit the opposite/adjacent wall without being routed a minimum of 180 degrees around the maintenance hole.
4. All cable routes shall be approved by the owner prior to installation.
5. Contractor shall supply outside plant multi-pair copper cable, outside plant optical fiber cable and electrical protection devices that will prevent electrical surges on the cable from entering buildings.
6. The cable distribution system shall be via underground conduit.
7. It shall be the responsibility of the Electrical Contractor to secure any permits required for the construction of the outside plant.

H. Riser Backbone

1. Electrical Contractor shall supply and install the transmission media and terminating hardware to provide interconnection between the ER and each TR in a star topology.
2. All cable routes shall be approved by owner prior to installation.
3. All fibers shall be run in inner duct or conduit and terminated in the ER/TR's with sufficient panels, couplers and jumper storage shelves to terminate and secure all fibers.
4. All riser backbone cabling shall be installed with a minimum of 10'-0" of slack at each point of termination.
5. The Electrical Contractor shall adhere to the manufactures recommendations and specifications with regard to the bending radius and pulling strength requirements of all backbone cables during handling and installation.

- I. Cable Pathways: All cabling shall be run in and supported by cable pathways that are installed solely for the purpose of supporting low voltage communications cabling.

J. Bonding and Grounding

1. The Electrical Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework.
2. All grounds shall consist of #6 AWG or larger (As required) copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground.
3. Grounding must be in accordance with the NEC, NFPA and all local codes and practices.

K. Electrical Protection

1. Electrical Contractor shall supply over current protectors and wires used to ground the equipment.
 2. The electrical protection devices supplied by the Electrical Contractor shall be in multi-pair form.
 3. For small pair count applications, Electrical Contractor shall supply electrical protection devices which consist of a mounting panel for a series of solid-state (or gas tube) protector units and a wiring block. The wiring block shall be used for input and output cable terminations. Insertion of the protector units into the mounting block will complete the circuit.
- L. Power Separation: The Electrical Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus. All SCS equipment and terminations must maintain proper separation from sources of EMI as per ANSI/TIA/EIA 562 B2 and 569-A and BICSI installation practices.
- M. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches** (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches** (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches** (610 mm).
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches** (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches** (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches** (300 mm).
 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

- b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.
- N. Miscellaneous Equipment: The Electrical Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding (ER & TR locations), miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the System.
- O. Special Equipment and Tools: It shall be the responsibility of the Electrical Contractor to furnish any special installation equipment or tools necessary to properly complete the System. Tools shall include, but are not limited to:
 - 1. Tools for terminating cables,
 - 2. Testing and splicing equipment for copper/fiber cables,
 - 3. Communication devices,
 - 4. Jack stands for cable reels,
 - 5. Cable wenchers.
- P. Identification
 - 1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.
 - a. Administration Class: 4.
 - b. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
 - 2. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration including optional identification requirements of this standard.
 - 3. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
 - 4. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and

workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

5. Cable and Wire Identification:

- a. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- b. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each innerduct at intervals not exceeding **15 feet (4.5 m)**.
- c. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1) Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
 - 2) Label each unit and field within distribution racks and frames.
- d. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

6. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following: Labels use flexible laminated vinyl or polyester that flexes as cables are bent.

Q. Cable Records: The Electrical Contractor shall provide all cabling records, both currently installed and new, in the latest version Panduit PIM format.

R. As Built Documentation

1. Upon completion of the project, Electrical Contractor is to prepare "As Built" documentation showing actual site conditions and installation as constructed.
2. Provide copies of such documentation to the Owner as mentioned below.
 - a. Upon completion of system installation, Electrical Contractor shall provide to Owner for its records the following:
 - 1) TR and ER Diagrams which shall include:
 - a) Cable routing
 - b) Position of all components and
 - c) Detailed layout of the wall field
 - d) Labeling plan.

- 2) Riser Distribution Plan
 - 3) Campus Distribution Plan
- b. Documentation shall be in the following format:
- 1) Four (4) copies and one reproducible sepia of all diagrams and drawings in "D" size (24" x 36") or "E" size (30" x 42") as appropriate.
 - 2) One (1) copy of electronic records provided in the latest AutoDesk AutoCAD format on four (4) CD/DVD-Rom discs.
 - 3) One (1) copy of electronic project records including cut sheets, test results (provided in both PDF format and the native tester file format) and cable connectivity schedules provided on four (4) CD/DVD-Rom discs.
- S. Additional Records: In addition to the engineering diagrams, the following items shall be provided by the Electrical Contractor: Cable Records and Assignments detailing all connections to equipment, horizontal cable or riser cable for both copper and fiber cables in Panduit PIM format.

3.4 PENETRATIONS OF WALLS, FLOORS AND CEILINGS

- A. Prior consent: The Electrical Contractor shall make no penetration of floors, walls or ceiling without the prior consent from the owner.
- B. Sealing penetrations – The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Electrical Contractor who pulled or placed the cables.
1. Where penetrations through acoustical walls or other walls for cableways have been provided for the Electrical Contractor or made by the Electrical Contractor such penetrations shall be sealed by the Electrical Contractor in compliance with applicable code requirements and as directed by Owner's Architect or General Contractor.
 2. Where penetrations through fire-rated walls for cableways have been provided for the Electrical Contractor or made by the Electrical Contractor such penetrations shall be sealed by the Electrical Contractor as required by code and as directed by Owner's Architect or General Contractor.

3.5 TESTING / WARRANTY

- A. Optical Fiber Cable Testing
1. All fiber testing shall be performed on all fibers in the completed end to end system. Testing shall be bidirectional.
 2. Testing shall consist of a bidirectional end to end OTDR trace performed per EIA/TIA 455-61 or a bidirectional end to end power meter test performed per EIA/TIA 455-53A. Optical Certification testers may be used if approved in advance by the engineer.

3. The system loss measurements shall be provided at (850 and 1310 nanometers for multimode fibers).
 4. Pre-installation cable testing
 - a. The Electrical Contractor shall test all fiber cable prior to the installation of the cable and provide the engineer of record with those test results prior to installation.
 - b. The Electrical Contractor shall assume all liability for the replacement of the cable should it be found defective.
 5. Loss Budget
 - a. Fiber links shall have a maximum loss of: Allowable cable loss per km)(km of fiber in link) + (.4dB)(number of connectors) = maximum allowable loss.
 - b. A mated connector to connector interface is defined as a single connector.
 - c. Any link not meeting the requirements of the standard shall be brought into compliance by the Electrical Contractor, at no charge to Owner.
 6. Complete, end to end, test results must be submitted to the engineer of record for review (provide both PDF format and native tester file format).
- B. Extended Product Warranty Work
1. Under the Extended Product the manufacturer shall replace any and all defective product or product not functioning to the levels guaranteed at the time of the warranty issue at the manufacturer's cost.
 2. The manufacturer shall engage an authorized manufacturer's reseller to repair or replace any such defective product on behalf of the manufacturer at no cost to the owner.
 3. The Extended Product Warranty shall include a minimum one (1) year installation warranty for the premises copper and optical cabling to correct all installation related problems/ issues at no cost to the owner.

3.6 COMPLETION OF WORK

- A. At the completion of the Work, the Electrical Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.
- B. All clean up, restoration, and removal noted above will be by the Electrical Contractor and at no additional cost.
- C. If the Electrical Contractor fails in its duties under this paragraph, Owner may upon notice to the Electrical Contractor perform the necessary clean up and deduct the costs there of from any amounts due or to become due to the Electrical Contractor.

3.7 INSPECTION

- A. On-going inspections shall be performed during construction by the Project Manager and/or System Engineer. All work shall be performed in a high quality manner and the overall appearance shall be clean, neat and orderly.

END SECTION 27 13 00

DIVISION 27 – TELECOMMUNICATIONS
SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

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. Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality, general configuration, and operating characteristics desired only. This specification is intended to be a minimum standard for function, operation and performance. Equipment catalog numbers are listed to establish this minimum.
- B. Section Includes:
 - 1. UTP cabling
 - 2. Cable connecting hardware, patch panels, and cross-connects.
 - 3. Telecommunications outlet/connectors.
 - 4. Cable management system.
- C. Related Requirements
 - 1. Division 27 Section "Grounding and Bonding for Communications Systems" for grounding and bonding of equipment room fittings.
 - 2. Division 27 Section "Pathways for Communications Systems" for cable trays and accessories.
 - 3. Division 27 Section "Communications Room Fittings" for equipment racks, cabinets and enclosures.
 - 4. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with distribution systems.

1.3 SUMMARY OF WORK

- A. Furnish and install complete with all accessories a horizontal Structured Cabling System (SCS). The SCS shall serve as a vehicle for transport of data, video and voice telephony signals throughout the network from designated demarcation points to outlets located at various desks, workstation and other locations as indicated on the contract drawings and described herein.
- B. Wiring utilized for data and voice communications shall originate at network switches and concentrators either wall mounted, in vertical free standing equipment racks, and/or enclosed wall mounted vertical equipment racks located at the telecommunications

Equipment Room (ER) and/or the Telecommunications Room (TR) location(s). All connectivity, wiring, terminations and patch bays between these designated demarcation points and outlet locations designated on the plans shall be considered part of the contract. Telecommunication Outlets (TO) shall be furnished, wired and installed by the SCS Electrical Contractor.

- C. The system shall utilize a network of fiber optic, and unshielded twisted pair copper, riser and tie cables. Cables and terminations shall be provided and located as shown and in the quantities indicated on the drawings.
 - 1. Fiber cables shall terminate on fiber patch panels and/or modular patch panels located at demarcation and termination points shown on the drawings.
 - 2. All cables and terminations shall be identified and labeled per owner specifications at all locations.
 - 3. All cables shall terminate in an alpha-numeric sequence at all termination locations.
- D. All copper cable terminations shall comply with, and be tested to ANSI/TIA 568-C standards for Category Cable installations.

1.4 REFERENCES

- A. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
- B. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Wiring Standards, General requirements.
- C. ANSI/TIA-568-C.2 - Commercial Building Telecommunications Wiring Standards, Balanced Twisted Pair Cabling Components.
- D. ANSI/TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces.
- E. ANSI/TIA-606-A – Administration Standards for Commercial Telecommunications Infrastructures.
- F. ANSI J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- G. International Standards Organization/International Electrotechnical Commission (ISO/IEC) 11801.
- H. Underwriters Laboratories (UL®) Cable Certification and Follow up Program.
- I. National Electrical Manufacturers Association (NEMA).
- J. American Society for Testing Materials (ASTM).
- K. National Electric Code (NEC®), 2014
- L. Institute of Electrical and Electronic Engineers (IEEE).
- M. UL Testing Bulletin.

- N. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps.
- O. BICSI – TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM) most recent version.

1.5 RESPONSIBILITY

- A. The term Electrical Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

1.6 DEFINITIONS

- A. Structured Cabling System (SCS): A SCS is defined as all required equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, telecommunication outlets, work area cords, UTP and fiber optic cable installed and configured to provide computer data and voice connectivity from each data or voice device to the network file server or voice network/switch designated as the service point of the local area network.
- B. Work Area: The connection between the information outlet and the station equipment in the work area consists of cords, adapters, and other transmission electronics.
- C. Horizontal Cabling: The horizontal cabling subsystem provides connections from the horizontal cross connect to the Telecommunication Outlets (TOs) in the work areas. It consists of the horizontal transmission media, the associated connecting hardware terminating this media and IOs in the work area. Each floor of a building is served by its own Horizontal Subsystem.
 - 1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 2. Bridge taps and splices shall not be installed in the horizontal cabling.
 - 3. Splitters shall not be installed as part of the optical fiber cabling.
- D. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- E. Riser Backbone: The Riser Backbone subsystem links the equipment room (ER) and telecommunications rooms (TR). It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology, with first-level backbone cables beginning at the equipment room.
- F. Campus Backbone: A Campus Backbone is used when a distribution system encompasses more than one building. The components and cables that provide the link between buildings constitute the Campus Backbone. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or power surges. It is normally first-level backbone cables beginning at the equipment room of the hub building and extending to the intermediate cross connect in the equipment room of a satellite building.

- G. Equipment Subsystem: The Equipment Subsystem consists of shared (common) electronic communications equipment in the equipment room, main cross connect or telecommunications closet and the transmission media required to terminate this equipment on the distribution hardware.
- H. The Administration Subsystem: The Administration Subsystem links all of the subsystems together. It consists of labeling hardware for providing circuit identification and patch cords or jumper wire used for creating circuit connections at the cross connects.
- I. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.

1.7 ACTION SUBMITTALS

A. Schedules

- 1. Within 30 days of the notice to proceed, submit a full and complete schedule, in the form of a GANNT chart, for all phases and aspects of the work. A break down by building, floor, and work type (e.g. material delivery, pathways installation, rack/cabinet/frame installation, cable pulling, termination, labeling, testing)
- 2. Schedule shall be fully coordinated with the overall construction schedule.
- 3. Schedule shall include dates when the contractor needs certain specific areas to be accessible (e.g. Equipment Rooms, Telecommunications Rooms, Cable Pathways)

B. Product Data

- 1. Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- 2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
 - a. All fiber optic and copper cable: to include cross connect wire and cross connect cordage.
 - b. All connectors and required tooling.
 - c. All termination system components for each cable type.
 - d. All grounding and building entrance protection surge suppression system components.
 - e. All test equipment to be used for fiber and copper channels
- 3. A technical data sheet showing manufacturer's Guaranteed Channel Performance over the full swept frequency range of the category specification.
- 4. Technical data sheets shall include the physical specifications as well as the following electrical and transmission characteristics for the cable:
 - a. Mutual Capacitance

- b. Impedance
- c. DC Resistance
- d. Attenuation
- e. Worst Pair-to-Pair Near End Crosstalk
- f. Power Sum Near End Crosstalk
- g. ELFEXT
- h. Power Sum ELFEXT
- i. Return Loss

C. Shop Drawings:

- 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
- 2. Cabling administration drawings and printouts.
- 3. Wiring diagrams to show typical wiring schematics, including cross-connects.
- 4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

D. Pre-Qualification Certificate

- 1. The Electrical Contractor shall submit the following documents with project proposal:
 - a. A letter of approval from the manufacturer indicating completion of pre-qualification requirements by installing vendor.
 - b. Submit proof from manufacturer of vendor's good standing in manufacturer's qualification program.
 - c. Submit training certificates for design, engineering and installation of the proposed products awarded to the Electrical Contractors assigned project manager and installers. (Only installers with manufacturer's certificate of competency in installing proposed SCS will be acceptable for this project).
 - d. The Equipment Provider and Electrical Contractor must offer a twenty (20) year extended warranty for the premises fiber cabling solution Material and Installation Guarantee and must be able to perform service under this warranty.
 - e. The Equipment Provider and Electrical Contractor must offer a twenty (20) year extended warranty for the premises copper cabling solution Material and Installation Guarantee and must be able to perform service under this warranty.

- f. The Equipment Provider shall guarantee at the time of the bid that all UTP Category cabling and optical fiber cabling and components meet or exceed specifications (including installation) of ANSI/TIA-568-C.1, 568-C.2, 568-C.3 and ANSI/TIA-569-B.

E. Warranty Documentation

1. Provide complete documentation regarding the manufacturer's Extended Product Warranty and Application Assurance Program shall be submitted as part of the proposal. This shall include, but is not limited to: a sample of the warranty that will be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues and guaranteed performance information.
2. A systems application assurance manual documenting the vendor supported applications and application guidelines shall be provided as part of the submittals.

1.8 INFORMATIONAL SUBMITTALS

- A. Manufacturer and on-site delivery test results for all cabling.
- B. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.9 CLOSEOUT SUBMITTALS

- A. As-Built Documentation: As specified in Section 3.7 /1. /2. /b.
- B. Test Results: Test results shall be submitted in both PDF form and in the native electronic file format of the test equipment.
 1. As specified in Section 3.8.
 - a. Copper Test Results
 2. Test equipment firmware and software versions.
 3. Test equipment proof of calibration documentation.

1.10 QUALIFICATIONS

- A. The electrical contractor selected to provide the installation of this system shall be trained by the manufacturing company in all aspects of design, installation, and testing of the products described herein so as to provide the manufacturer's warranty of the system.
- B. The Electrical Contractor shall utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- C. The Electrical Contractor and design firm shall be in compliance with all federal, state and local statutes regarding qualifications of firms.
- D. The Electrical Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and metallic copper premise distribution systems.

1.11 QUALITY ASSURANCE

- A. The Electrical Contractor shall guarantee that all twisted pair copper and fiber optic cabling, cable pathways and associated components meet or exceed specifications (including installation) of ANSI/TIA/EIA-568-C.1, 568-C.2, 568-C.3 and 569-B.
- B. Personnel/ Installer Qualifications: Submit credential and qualification information for each of the following individuals:
 - 1. Installation Supervisor
 - 2. Field Inspector
- C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A and BICSI's Telecommunications Distribution Methods Manual.
- F. Grounding: Comply with ANSI-J-STD-607-A.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight.
 - 2. Visually inspect all cable upon delivery for damage during transport.
 - 3. Store cables in dry areas that are free of potential pre-installation damage.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 HORIZONTAL STRUCTURED CABLING SYSTEM

- A. Horizontal cabling shall be Category 6 4-pair unshielded twisted pair (UTP) cabling that meets the channel requirements.

- B. The horizontal structured cabling system specified in this specification shall be manufactured either by a single manufacturer or two manufacturers holding a high level partnership capable of providing the extended warranty outlined above. Including:
 - 1. 4-Pair UTP Cabling
 - 2. Modular RJ-45 Jacks
 - 3. Modular Faceplates
 - 4. Patch Panels
 - 5. Patch/ Station Cords
 - 6. 110-Style Punch Blocks
- C. Acceptable Horizontal Structured Cabling System Manufactures:
 - 1. Panduit
 - 2. Commscope/Systimax
 - 3. Belden

2.2 PRODUCT WARRANTY AND APPLICATION ASSURANCE

- A. The Structured Cabling System (SCS) shall be provided with an Extended Product Warranty and Application Assurance Program guaranteeing performance and operation of the SCS (including optical fiber and copper cabling).
- B. Extended Product Warranty

The Extended Product Warranty covers product defects for all passive components of the SCS. Passive components are defined as those exhibiting no gain or contributing no energy. The manufacturer shall warrant, from the date a Registration Certificate is issued by the manufacturer to the end-user, the following:

- 1. The passive products that comprise the registered SCS will be free from manufacturing defects in material or workmanship under normal and proper use.
 - 2. All SCS approved passive cabling products that comprise the registered SCS solution exceed the specification of ANSI/TIA-568-C.1, ANSI/TIA-568-C.2, ANSI/TIA-568-C.3 and exceed ISO/IEC 11801 standards and will conform to the guaranteed minimum performance specifications guaranteed head room published within the manufacturer's associated product data sheet and warranty platform documentation in effect at the time the Registration Certificate is issued for the duration of the extended warranty period.
- C. Application Warranty
 - 1. The Application Warranty shall cover failure of the SCS to operate all applications which the system was designed to support and all future applications which are developed to operate over ANSI/TIA-568-C permanent link/ channels.

2. The manufacturer shall warrant that the registered SCS solution will be free from failures which prevent operation of the specific applications for which the original SCS was designed.
3. Applications introduced in the future by recognized standards or user forums that utilize ANSI/TIA-568-C or ISO/IEC 11801 components and link/channel specifications for cabling shall be covered by the Application Warranty.

D. Term of Warranty

1. The Extended Product and Application Assurance Warranty shall span minimum 20 years from the date of issuance of the Registration Certificate or completion of installation, whichever is later.
2. The warranty shall be for the benefit of the person or entity to which the manufacturer's SCS Registration Certificate is issued and any successor in interest to the site in which such System was originally installed by the manufacturer or an Authorized manufacturer's Reseller.
3. If the manufacturer repairs the product, the repair shall utilize only new replacement parts. Replacement of existing parts shall be with new parts of the same design meeting or exceeding the performance of the replaced parts. Any such repair or replacement shall include a warranty for either 90 days or the remainder of the original warranty period, whichever is longer.

2.3 HORIZONTAL CABLING

A. Acceptable Cable Manufacturers:

1. Panduit: Pan Net TX6000
2. Systimax 71E GigaSPEED XL
3. Berk-Tek LANMark 1000/2000
4. General Cable GenSPEED 6500E
5. Belden 2413 Enhanced
6. Commscope 7504

B. Description: 100-ohm, four-pair UTP cable.

1. Comply with ICEA S-102-700-2004 for Category 6.
2. Comply with ANSI/TIA-568-C.2 for Category 6.
3. All cables shall be Plenum Rated, and certified with the copper solution manufacturer as to provide the manufacturer's extended warranty as specified.
4. ALL Cable shall be verified using a UL Holographic identity card; non-conforming cable shall be rejected and replaced by the supplier.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

- a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
- b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

C. Category 6 Guaranteed Channel Performance

- 1. The Category 6, 4 pair UTP channel shall consist of all cable and components with four connections that comprise the full 100 meter (328 feet) length circuit from the Hub/Server/LAN Electronics port located in the ER and/or TR to the device port located at the User Work Station.
- 2. All copper cable and apparatus shall conform to the Category 6/ Class E Channel Performance Specification.
- 3. The Category 6, 4 pair UTP channel shall be capable of providing stable and continual performance up to 250 MHz over the entire swept frequency range.
- 4. The Category 6 cable and components shall be electrically compatible with future networks and backward compatible with existing Category 3, 5, 5e. Components of the Category 6 channel shall be engineered and manufactured to compensate for any Category 3, 5 or 5e component crosstalk and shall provide at least Category 3, 5 or 5e performance in all of the customer's existing installed base of voice/data/video. The Category 6 cable and components shall be physically compatible with existing installed base of equipment.
- 5. The Category 6 cable and components shall not require special cords, specialty tools or special installation requirements.
- 6. The Category 6, 4 pair UTP channel shall be capable of providing stable and continual performance from 0 MHz to 250 MHz over the entire swept frequency range.
- 7. The Delay Skew on the 100 meter channel shall not exceed 50 ns.
- 8. Each installed channel (consisting of cable, cords and up to four connections) shall provide the following performance above (margin/ headroom) the ANSI/TIA-568-C.2 standard for a Category 5e four connector channel over the entire swept frequency range from 0 MHz to 250 MHz:
 - a. Insertion Loss: 5.0%
 - b. NEXT (Near End Cross Talk): 6.0 dB
 - c. PSNEXT (Power Sum Near End Cross Talk): 7.5 dB
 - d. ELFEXT (Equal Level Far End Cross Talk): 6.0 dB
 - e. PSELFEXT (Power Sum Equal Level Far End Cross Talk): 8.0 dB
 - f. Return Loss: 2.0 dB

2.4 OUTLETS

- A. Faceplates

1. Acceptable Manufacturers:
 - a. Panduit: Mini Com Classic Sloped Faceplate
 - b. Systimax: LE Series Faceplate
 - c. Commscope: 107713 Angled Faceplate
 - d. Belden Mediaflex with Angled Inserts
2. General Requirements
 - a. Faceplates shall be available in single, duplex, quadplex, and sixplex arrangements in a single gang configuration.
 - b. The outlets shall be capable of being installed in any modular faceplate, frame, flush mounted box or surface-mounted box avoiding the need for special faceplates.
 - c. Faceplate outlet openings shall be numbered on both sides for installation and maintenance identification.
 - d. Faceplate shall be installed with the number of ports as required by the designated outlet. Each unused port shall contain a blank insert.
 - e. Modular jack mounting in faceplate shall be in a vertically sloped/ angled configuration.
3. Modular Flush Mounted Faceplates
 - a. Faceplates shall be High-impact, flame retardant, UL-rated 94V-0 thermoplastic.
 - b. The standard faceplate color shall be white or off-white unless noted otherwise on the plans.
4. Metal Modular Faceplates shall be stainless steel.

B. Category 6 Gigabit outlets

1. Acceptable Manufacturers:
 - a. Panduit: Mini-Com TX6 Plus Jack Modules
 - b. Commscope Gigaspeed XL MGS400
 - c. Belden Gigaflex PS6+
2. All Category 6 outlets shall meet or exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA-568-C.2 Commercial Building Telecommunications Cabling Standard, ISO/IEC 11801:2002 Second Edition and be part of the UL® LAN Certification and Follow-up Program.

3. The Category 6 outlets shall be backward compatible with Category 5e, 5 and 3 cords and cables.
4. Category 6 RJ-45 jacks shall be:
 - a. 8-position/ 8-conductor modular outlets.
 - b. Terminated utilizing insulation displacement.
 - c. Equipped with T568A and T568B universal wiring labels.
5. The outlet shall accept either the T568A or T568B wiring configurations. The T568B wiring scheme shall be used.
6. General specifications:
 - a. Meets or exceeds the mechanical, electrical, and clearance specifications in FCC Rules and Regulations, Part 68, Subpart F
 - b. Meet or exceed the Category 6 requirements in ISO/IEC 11801, CENELEC EN 50173, and ANSI/TIA-568-C.2.
 - c. Certifications: UL Listed, CSA Certified and AUSTEL approved.
7. Color of jacks:
 - a. ALL JACKS: White/Off White (IW) to match faceplate

2.5 MODULAR PATCH PANELS

- A. Approved Patch Panels
 1. 48-Port Patch Panel
 - a. Panduit: CP48WSBLY
 - b. Commscope M2000-48
 - c. Belden Key Connect AX103115
- B. The Category 6 modular jack panels shall meet or exceed the Category 6 standards requirements in ISO/IEC 11801 (2002), CENLEC EN 50173 (2002) and ANSI/TIA-569-C.2-10 and shall be UL Listed.
- C. The 48 port panel shall be 2RU in height, (1 RU for 24 port) capable of accepting modular jacks.
- D. The jack panels shall be 19-inch rack mountable.
- E. The patch panel shall be available in 24 and 48 port configurations.
- F. The patch panel shall ensure alien crosstalk performance.
- G. Provide horizontal wire management containing patch cord organizers between each modular patch panel as shown on project drawings.

1. Shall have horizontal routing via metal distribution rings
2. Shall have plastic clips to provide vertical pathways for patch cables

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Components of the SCS system shall be installed in a neat, workmanlike manner.
- B. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system.
- C. Identification markings and systems shall be uniform.

3.2 WIRING METHODS

- A. Install cables in raceways and cable trays. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- B. Provide a minimum 6'-0" of service loop/ figure eight at the telecommunications rooms for each permanent link.
- C. Provide a minimum of 18" of service loop/ figure eight in the ceiling above the telecommunications outlet for each channel.
- D. Provide a minimum of 8" slack of cable at each copper UTP outlet location for jack termination.
- E. Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 REQUIREMENTS FOR CABLE ROUTING AND INSTALLATION

- A. Cabling
 1. All communications cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC®) Articles 725, 760, 770, and 800 and the appropriate local codes.
 2. All copper cabling shall bear CMP (Plenum Rated) and/or appropriate markings for the environment in which they are installed.
- B. Cable Pathway
 1. In suspended ceiling and raised floor areas where duct, cable trays or conduit are not available, the Electrical Contractor shall bundle, in bundles of 50 or less, station wiring with cable ties snug, but not deforming the cable geometry.
 2. Cable bundles shall be supported via "J" hooks or Ring attached to the existing building structure and framework at intervals of four (4) feet average with a maximum separation of five (5) feet

3. Plenum rated cable ties shall be used in all appropriate areas.
4. The Electrical Contractor shall adhere to the manufacturers' requirements for bending radius and pulling tension of all data and voice cables.
5. All cabling shall be run in and supported by cable pathways that are installed solely for the purpose of supporting low voltage communications cabling.
6. Cables shall not be attached to lift out ceiling grid supports or laid directly on the ceiling grid.
7. Cables shall not be attached to or supported by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space.
8. Cables shall maintain adequate separation from EMI and heat sources such as lighting fixtures etc.
9. Coordinate the support of cable pathways support systems with the work of other trades.
10. Coordinate routing of cable pathways with the work of other trades to maintain adequate working clearances above, below and to the sides of cable pathways.
11. Coordinate with other contractors during the final BIM coordination meetings to provide shared hangers to support cable pathway systems.

C. Penetrations of Walls, Floors and Ceilings

1. Prior consent: The Electrical Contractor shall make no penetration of floors, walls or ceiling without the prior consent from owner.
2. Sealing penetrations: The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Electrical Contractor who pulled or placed the cables.
3. Penetrations through acoustical walls or other walls for cableways that have been provided for the Electrical Contractor or made by the Electrical Contractor such penetrations shall be sealed by the Electrical Contractor in compliance with applicable code requirements and as directed by Owner's Architect or General Contractor.

D. Fire Stopping

1. Responsibility for sealing of opening around the exterior of the low voltage system sleeves shall be by the contractor as described below:
 - a. Sleeves through fire rated and smoke walls created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.

- b. Sleeves through fire rated and smoke walls created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
 - c. Sleeves of openings between floors created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
 - d. Sleeves of openings between floors created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
- 2. Sealing of the space internal to all sleeves or openings specifically designated for telecommunications cabling shall be the responsibility of the Electrical Contractor.
 - 3. Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over this work.

E. Electrical Contractor Responsibility

- 1. The Electrical Contractor shall be responsible for damage to any surfaces or work disrupted as a result of his work. Repair of surfaces, including painting, shall be included as necessary.
- 2. The Electrical Contractor shall ensure that all recommended cable pulling tensions and pulling bending radius are not exceeded. Any cable bent or kinked to a radius less than the recommended dimension shall not be installed. Any cable that is bent or kinked to a radius less than the recommended dimension during installation shall be replaced by the Electrical Contractor at no additional cost to the project.

F. Horizontal Cabling

- 1. The Electrical Contractor shall supply horizontal cables to connect each information outlet to the backbone subsystem on the same floor.
- 2. Unless otherwise noted on the floor plans or within this document, the type of horizontal cables used for each work location shall be 4-pair unshielded twisted pair (UTP).
- 3. The 4-pair UTP cables shall be run using a star topology format from the administration subsystem (Telecommunications Room) on each floor to every individual Telecommunication Outlet.
- 4. All cable routes are to be parallel and/or perpendicular with the outside walls of the building. Alternate paths must be approved by the engineer of record prior to installation of the cabling.
- 5. The length of each individual run of horizontal cable from the administration subsystem (Telecommunications Room) on each floor to the Telecommunication Outlet shall not exceed 295 ft (90 m).

6. Conduit runs installed by the Electrical Contractor should not exceed 100 feet or contain more than two 90 degree sweeping bends without utilizing appropriately sized pull boxes.
7. The Electrical Contractor shall adhere to the manufactures recommendations and specifications with regard to the bending radius and pulling strength requirements of the 4-pair UTP cable during handling and installation.
8. The Electrical Contractor shall maintain the horizontal UTP cable twist rate for each pair in the cable to within 0.5-inches of the cable termination or to the manufacturer's termination instructions, whichever is more stringent. The cable jacket shall be removed only to the extent required to make the termination.
9. Each run of cable between the termination block and the information outlet shall be continuous without any joints or splices.
10. In suspended ceiling and raised floor areas where walker duct, cable trays or conduit are not available, the Electrical Contractor shall bundle station wiring with Velcro type cable ties at appropriate distances.
11. The Electrical Contractor shall conceal horizontal distribution wiring internally within the walls. If obstructions exist, the Electrical Contractor shall secure approval by Engineer prior to the use of an alternate method.
12. Every effort will be made to schedule the requirements under this Contract in such a manner so as to complete all above ceiling work without deconstruction of the existing ceiling system. In the event the Electrical Contractor is required to remove ceiling tiles, such Work shall not break or disturb grid and must be replaced to match existing if damaged.

3.4 ADMINISTRATION

- A. The administration subsystem shall consist of wiring blocks and or patch panels for termination of copper cables or optical fibers. All wall field layouts to be as detailed on drawings or as approved by Engineer prior to installation.
- B. Fields: Separate termination fields shall be created for voice and data applications if both are wall mounted.
- C. Termination blocks: Termination blocks that require rotation after connection of horizontal/vertical wiring shall not be allowed.
- D. Cross-connect wire: The Electrical Contractor shall provide cross-connect for cross connection and inter-connection of termination blocks.

3.5 SOURCE QUALITY CONTROL

- A. Factory test UTP cables on reels according to ANSI/TIA-568-C.1.
- B. Test UTP cables according to ANSI/TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 INSTALLATION

- A. The Electrical Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals and shop drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.
- B. Throughout the project, the Electrical Contractor shall provide levels of manpower necessary to meet all construction schedules.
- C. All installation shall be done in conformance with ANSI/TIA-568-C standards, federal and local standards and the SCS manufacturer Design and Installation guidelines.
 - 1. The Electrical Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Electrical Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation at no additional cost to the owner. This shall also apply to any and all damages sustained to the cables by the Electrical Contractor during the implementation.
 - 2. The Electrical Contractor shall make provisions so that all cabling is stored within a temperature controlled space to ensure that cabling is unspooled, manipulated, and worked with only when the cabling is within the manufacturer's installation temperature specifications and free of condensation.
- D. Bonding and Grounding
 - 1. Comply with requirements in Division 27 Section "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
 - 2. Comply with ANSI-J-STD-607-A.
 - 3. Grounding must be in accordance with the NEC, NFPA and all local codes and practices.
 - 4. The Electrical Contractor shall be responsible for providing an approved ground at all newly installed distribution frames, and/or insuring proper bonding to any existing facilities.
 - 5. The Electrical Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework.
- E. Power Separation: The Electrical Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
- F. Separation from EMI Sources:
 - 1. Comply with Article 800.52 of ANSI/NFPA 70, BICSI TDMM and ANSI/TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches** (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches** (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches** (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches** (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches** (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches** (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches** (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches** (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches** (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches** (127 mm).
- G. Miscellaneous Equipment: The Electrical Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding (ER & TR locations), miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the SCS system.
- H. Special Equipment and Tools: It shall be the responsibility of the Electrical Contractor to furnish any special installation equipment or tools necessary to properly complete the System. Tools shall include, but are not limited to:
 1. Tools for terminating cables,
 2. Testing and splicing equipment for copper/fiber cables,

3. Communication devices,
4. Jack stands for cable reels,
5. Cable wenchers.

3.7 IDENTIFICATION/ LABELING

- A. The Electrical Contractor shall be responsible for generating and placing printed labels for all cables and cords, distribution frames, and outlet locations at the time of delivery.
- B. Adhere to the standards for identification/labeling as shown on project drawings.
- C. All horizontal cables shall be labeled within 4" of terminations on each end using the full labeling scheme specified below (RRRR-LL-J).
- D. Labels shall not be written by hand.
- E. Patch Panel Jack Identification and Labeling: Each jack module shall be labeled with the format: RRRR-LL-J
 1. "RRRR" shall be the Owner's Room Number
 - a. Coordinate room numbers with the owner prior to labeling; the Owner's Room Number may not necessarily be the same as the Architectural Room Number.
 - b. In the case of telecommunications rooms, use the numbering scheme as shown on project drawings (e.g. E101 for Equipment Room 101 or T303 for Telecommunications Room 303).
 2. "LL" shall be a two-digit number indicating the outlet location within the room.
 - a. The outlet location numbering shall start with 01 which shall be the first outlet located to the left of the door when entering the room. In rooms with more than one door, any door between the room and a hallway may be used as the starting point.
 - b. Continue numbering outlets 02, 03, etc. continuing clockwise around the room along the walls.
 - c. Continue lettering floor mounted outlets 04, 05, etc. from left to right the front to back across the room when facing into the room from the door.
 - d. Continue lettering ceiling mounted outlets 06, 07, etc. from left to right then front to back across the room when facing into the room from the door.
 3. "J" shall be the individual jack number within the outlet faceplate.
 - a. Jack Position #1 (Upper Left)
 - b. Jack Position #2 (Upper Right)
 - c. Jack Position #3 (Lower Left)

- d. Jack Position #4 (Lower Right)
- 4. "C" shall identify the Rack or Cabinet number within the telecommunication room (e.g. A or B)
- 5. "F" shall identify the MPP field number within each rack or cabinet.
- F. Station Outlet Identification: Each outlet shall be labeled with the format: RRRR-C-F-JJ detailed above.
- G. Identification:
 - 1. Identify system components, wiring, and cabling complying with ANSI/TIA-606-A-1. All newly and installed cabling AND existing cabling shall be labeled.
 - a. Administration Class: 4.
 - b. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
 - 2. Paint and label colors for equipment identification shall comply with ANSI/TIA-606-A-1 for Class 4 level of administration, including optional identification requirements of this standard.
 - 3. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
 - 4. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA-606-A-1. Furnish electronic record of all drawings, in software and format selected by Owner.
 - 5. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-A-1.
- H. Color Coding Scheme for Locating Hidden Drops

1. Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include all data drops above ceilings. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated below:

Color	System	Location
Orange	Telecommunications	At all Concealed Outlets above Ceilings

1.

I. As-Built Documentation

1. Upon completion of the project, Electrical Contractor is to prepare "As-Built" documentation showing actual site conditions and installation as constructed. All newly installed AND existing information outlet locations shall be located on as-built drawings.
2. Provide copies of such documentation to Owner as mentioned below.
 - a. Upon completion of system installation, Electrical Contractor shall provide to Owner for its records the following:
 - 1) ER and TR Diagrams which shall include:
 - a) Cable routing
 - b) Position of all components and
 - c) Detailed layout of the wall field
 - d) Labeling plan.
 - 2) Work Area Floor Plans which shall Include:
 - a) Detailed cable routes
 - b) Approved labeling plan for all work areas.

- 3) Riser Distribution Plan
 - 4) Cable Tray, Conduit, and Raceway Plans
 - 5) Campus Distribution Plan
- b. Documentation shall be in the following format:
- 1) Four (4) copies and one reproducible sepia of all diagrams and drawings in "D" size (24" x 36") or "E" size (30" x 42") as appropriate.
 - 2) One (1) copy of electronic records provided in the latest AutoDesk AutoCAD format on four (4) CD/DVD-Rom discs.
 - 3) One (1) copy of electronic project records including cut sheets, test results (provided in both PDF format and the native tester file format) and cable connectivity schedules provided on four (4) CD/DVD-Rom discs.
- J. Additional Records: In addition to the engineering diagrams, the following items shall be provided by the Electrical Contractor: Cable Records and Assignments detailing all connections to equipment, horizontal cable or riser cable for both copper and fiber cables.

3.8 TESTING / WARRANTY

A. Copper Cable testing

1. Testing of all copper wiring shall be performed prior to system acceptance.
2. One hundred percent of the permanent installed links shall be tested for conformance to the manufacturers guaranteed performance levels as specified in the manufacturer's Extended Product Warranty platform.
 - a. Any pairs not meeting or exceeding the requirements of the guaranteed performance levels shall be brought into compliance by the contractor, at no charge to the owner.
 - b. All cabling shall exceed the specifications of ANSI/TIA-568-C.2 (specific to the Category standards the cabling is manufactured to) by the margins (headroom) specified in the manufacturer's Extended Product Warranty platform.
3. One hundred percent of the horizontal and riser wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.
4. The Electrical Contractor shall utilize a Fluke DTX-1800 Cable Analyzer to test all unshielded twisted pair cabling.
5. Test equipment shall be updated with the latest firmware and software releases available from the manufacturer of the test equipment.

6. All test equipment shall include valid proof of calibration within 12 months of the testing date. The calibration shall utilize the manufacturer's recommended calibration practices.
7. One hundred percent of horizontal cables shall be tested according to the manufacturer's instructions utilizing the latest firmware and software.
 - a. Testing shall include all of the electrical parameters.
 - b. The detailed test results shall include the following:
 - 1) Wire Map
 - 2) Length
 - 3) Insertion loss
 - 4) Near-End Cross Talk (NEXT)
 - 5) Power Sum Near-End Crosstalk (PSNEXT)
 - 6) Equal-Level Far End Crosstalk (ELFEXT)
 - 7) Power Sum Equal-Level Far-End Crosstalk (PSELFEXT)
 - 8) Return Loss
 - 9) Propagation delay
 - 10) Delay skew
8. Complete, end to end, test results shall be submitted to Engineer for review.

B. Extended Product and Application Assurance Warranty Work

1. Under the Extended Product and Application Assurance Warranty, the manufacturer shall replace any and all defective product or product not functioning to the levels guaranteed at the time of the warranty issue at the manufacturer's cost.
2. The manufacturer shall engage an authorized manufacturer's reseller to repair or replace any such defective product on behalf of the manufacturer at no cost to the owner.
3. The Extended Product Warranty shall include a minimum one (1) year installation warranty for the premises copper and optical cabling to correct all installation related problems/ issues at no cost to the owner.

3.9 COMPLETION OF WORK

- A. At the completion of the System, the Electrical Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.

- B. All clean up, restoration, and removal noted above will be by the Electrical Contractor and at no additional cost.

3.10 INSPECTION

- A. On-going inspections shall be performed during construction by the Project Manager and/or System Engineer. All work shall be performed in a high quality manner and the overall appearance shall be clean, neat and orderly.
- B. Upon completion of the project, the engineer representative will perform a final inspection of the installed cabling system with a Electrical Contractor's representative. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the drawing package.

END SECTION 27 15 00

CONDUCTORS, CABLES AND CONNECTORS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 RELATED WORK AND REQUIREMENTS

- A. Section 26 05 26 Grounding and Bonding for Electrical Systems
- B. Section 26 05 33 Raceway and Boxes for Electrical Systems
- C. Section 27 05 28 Pathways for Communication Systems
- D. Section 27 05 26 Grounding and Bonding for Communication Systems
- E. Section 28 20 00 Electronic Access Control (EAC) Systems

1.2 SUMMARY

- A. Section Includes:
 - 1. RS-232 cabling.
 - 2. RS-485 cabling.
 - 3. Low-voltage control cabling.
 - 4. Control-circuit conductors.

1.3 REFERENCES

- A. ANSI/NFPA 70 – National electrical code
- B. BICSI Telecommunications Distribution Methods Manual

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended location and application.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight.
 - 2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
 - 3. Test each pair of UTP cable for open and short circuits.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system

is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 SUBMITTALS FOR RECORD ONLY

A. Product Data

PART 2 PRODUCTS

2.1 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Outer Jacket: LS-PVC (Low Smoke Polyvinylchloride).
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Insulation Material: FEP (Fluorinated Ethylene Propylene).
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.2 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Insulation Material: FR-PVC (Flame Retardant Polyvinylchloride).
3. Inner Shield: Aluminum Foil-Polyester Tape with 100% coverage.
4. Outer Jacket: LS-PVC (Low Smoke Polyvinylchloride).
5. Flame Resistance: NFPA 262, Flame Test.

2.3 ACCESS CONTROL CABLE

A. Low-voltage control cable shall be sequentially marked at two-foot intervals.

B. Low-voltage control cabling shall be multi-conductor composite access control plenum rated cable.(banana-peel composite cabling), NFPA 70 Art 800, Type CMP. Equal to Belden 858AFJ with the following:

1. 4C 18AWG, Shielded, Gray.
2. 3TP 22 AWG, OAS, Orange.
3. 2C 22 AWG, Shielded, White.
4. 4C 22AWG, Shielded, Blue.
5. Overall PVDF Jacket, Yellow, NFPA 262 Flame-arrest.

C. Plenum-Rated, Paired Reader Cable: NFPA 70, Type CMP.

1. 3 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Shielded.
4. Plastic jacket.

5. Flame Resistance: NFPA 262, Flame Test.
- D. Plenum-Rated Door Contact Cable: NFPA 70, Type CMP.
1. 2 No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Fluorinated ethylene propylene insulation.
 3. Shielded.
 4. Plastic jacket.
 5. Flame Resistance: NFPA 262, Flame Test.
- E. Plenum-Rated Request-to-Exit/ Spare Cable: NFPA 70, Type CMP.
1. 4 No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Fluorinated ethylene propylene insulation.
 3. Shielded.
 4. Plastic jacket.
 5. Flame Resistance: NFPA 262, Flame Test.

2.4 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.
- C. Class 3 Remote Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.5 SECURITY CABLE

- A. Plenum-Rated Motion Sensor/Security Cable: NFPA 70, Type CMP.
1. 4 No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Fluorinated ethylene propylene insulation.
 3. Shielded.
 4. Plastic jacket.
 5. Flame Resistance: NFPA 262, Flame Test.

PART 3 EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- D. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- E. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (75 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 INSTALLTION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than ½ inch rom the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Security cabling shall be provided with a separate pathway and shall NOT be combined in pathways with other communications cabling.
3. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
4. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
5. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
6. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
7. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.4 CONNECTIONS

- A. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.
- B. Comply with requirements in Division 28 Section "Fire Detection and Alarm" for connecting, terminating, and identifying wires and cables.

3.5 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.

3.6 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Tests and inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

END SECTION 28 05 13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1 (1981; R 1992) Requirements for Electrical Analog Indicating Instruments

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM B32 (2008; R 2014) Standard Specification for Solder Metal

ASTM D709 (2013) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100 (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 2 (2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V

NEMA ICS 6 (1993; R 2011) Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS (SMPTE)

SMPTE 170M (2004) Television - Composite Analog Video Signal - NTSC for Studio Applications

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-232 (1997f; R 2012) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 294 (2013) Access Control System Units

UL 497B (2004; Reprint Dec 2012) Protectors for Data Communication Circuits

UL 796 (2010; Reprint Sep 2013) Standard for Printed-Wiring Boards

1.2 STANDARD PRODUCTS

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that have been in satisfactory use at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site.

1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.
1. Active mode: That in which some type of signal is continuously sent across the link, resulting in simple link breaks being readily detected.
 2. Fail-safe: The capability to monitor system functions and report an alarm when a failure is detected in a critical system function.
 3. Installer: Either the Contractor or a subcontractor with whom the Contractor has a firm contractual agreement.
 4. Sensor zone: A geographic position for which an intrusion must be identified and displayed and may be the combination of multiple detection devices.
 5. Element: As used in this section means a constituent part of a complex signal such as an ac or dc voltage or current, ac phase, or frequency duration.

1.4 SYSTEM DESCRIPTION

Provide new Access Control System (ACS) devices, including associated equipment and appurtenances that are compatible with the district's existing S2 system. The design of the ACS shall include all devices, wiring and equipment required to control access, and deny unauthorized entries within specific areas. Report generation, Photo Identification badges, and annunciation of alarms are existing at the district level. The ACS shall be designed to provide operational flexibility and reliable performance. The ACS shall be modular, allowing for future incremental expansion or modification of inputs, outputs, and remote control stations. Each system shall be complete and ready for operation and provide for a fully integrated access control solution.

1.5 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

Shop Drawings

- ACS components

- Overall system schematic

Product Data

- Card reader/Keypad

- Door Contacts

- Request to Exit

- Communications interface devices

- Power Supplies

Test Reports

- ACS operational test plan

Certificates

- ACS operational test plan

- Installer's qualifications

- Instructor's qualifications

Operation and Maintenance Data

- ACS components

Closeout Submittals

- As-Built drawings for ACS

- Posted operating instructions for ACS

1.6 QUALITY ASSURANCE

A. Drawings

1. ACS Components: Submit drawings that clearly and completely indicate the function of each ACS component. Indicate termination points of devices, and interconnections required for system operation. Indicate interconnection between modules and devices. In addition, submit a layout drawing showing spacing of components, location, mounting and positioning details.
2. Overall System Schematic: Indicate the relationship of integrated components on one diagram and show power source, system controls, voltages; plus number, size, identification, and maximum lengths of interconnecting wires. Drawings shall be not less than 24 by 36 inches.

B. Experience and Qualifications

1. Installer's Qualifications: Prior to installation, submit data of the installer's experience and certified qualifications. Show that the installer who will perform the work has a minimum of 2 years experience successfully installing ACS of the same type and design as specified herein. Include the names, locations, and points of contact of at least two installations of the same type and design as specified herein where the installer has installed such systems. Indicate the type of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 12 months.
2. Instructor's Qualifications: Prior to installation, submit data of the instructor's experience and certified qualifications. Show that the instructor, who will train operating and maintenance personnel, has received a minimum of 24 hours of ACS training from the manufacturer, and 2 years experience in the installation of ACS of the type specified.

C. Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Regional Office of Education. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1. Reference Standard Compliance: Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance
2. Independent Testing Organization Certificate: In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide only UL listed ACS equipment for Both exterior and interior access control.

D. ACS Operational Test Plan

Submit at least 30 days prior to commencement of formal operational testing. Include detailed procedures for operational testing of each ACS component and subsystem, and for performance of an integrated system test.

E. Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section

1. Alternative Qualifications: Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished
2. Material and Equipment Manufacturing Date: Products manufactured more than 1 years prior to date of delivery to site shall not be used, unless specified otherwise.

PART 2 PRODUCTS

2.1 ACS SUBSYSTEMS

- A. Provide components that are compatible with the district's existing S2 enterprise access control system; provide a complete integrated ACS consisting of the following major subsystems:
 1. Automated Access Control System Hardware and Software – Door Controllers
 - a. S2 Network Node; Includes 1 S2 (2 Door) access control application blade with 6 available expansion slots, wall mounted. Model S2-NN-E2R-WM.
 2. Power Supplies
 - a. Dyna Lock Corp. Power Supply 5500 Series with 90 minutes of battery back-up.
 3. Communications/Cabling/Wiring – See Section 28 05 13
 4. Card Readers
 - a. HID MiniProx
 5. Keypad/Card Readers
 - a. Essex PPH-103-SN, weatherproof and vandal resistant, stainless steel finish.
 6. Request to Exit
 - a. Bosch DS 160
 7. Door Contacts
 - a. Bosch ISN-CSM20-WG Commercial Contacts
 - b. Honeywell 7940

2.2 INTEGRATED SYSTEM FUNCTIONAL REQUIREMENTS

- A. Ensure that ACS is fully integrated with physical security and other elements of the existing S2 District security system. Provide specific subsystem consisting of the following:
 - 1. Automated Access Control subsystem: Door Access Control Nodes, and Electronic devices to include Door Contacts, Card Readers, and Request to Exit sensors/modules to control personnel movement through normal access routes in and out of the school.
 - 2. Communications subsystem: Cabling/wiring between elements required to ensure that pertinent data is transferred from point of origin to point where appropriate actions can be taken
 - 3. Power subsystem: Components required to ensure continuous operation of the entire ACS.

2.3 INTEGRATED SYSTEM PERFORMANCE REQUIREMENTS

The installed and operating ESS shall be integrated into the overall facility to detect intrusion, Control Access, provide Closed Circuit Television (CCTV) surveillance, provide visual verification and shall perform as an entity, as specified below.

A. Fail-Safe Capability

Provide fail-safe capability in critical elements of the ACS. This shall include, but not be limited to, capability to monitor communication link integrity and to provide self-test. When diminished functional capabilities are detected, system shall provide annunciation of the fault. Fail-safe alarms shall be annunciated to be clearly distinguishable from other types of alarms.

B. Line Fault Detection

Communication links of the ACS shall have an active mode for line fault detection. System shall be either a static, or dynamic system. In a static system, the "no-alarm" condition shall always be represented by the same signal, which shall be different than the signal originally transmitted. The dynamic system shall represent "no-alarm" with a signal which continually changes with time.

C. Power Loss Detection

Provide capability to detect when a critical component of the system experiences temporary or permanent loss of power and to declare an alarm. Alarm shall be annunciated to clearly identify the component experiencing power loss.

D. Electrical Power

Obtain by PoE connection from district provided Ethernet switches powered by normal electrical distribution system. UPS backup power will also be provided through district equipment.

2.4 SYSTEM PERFORMANCE REQUIREMENTS

Design system components to operate as described herein within the context of the overall system performance previously described. Perceived inconsistencies between the following component performance specifications and overall system level performance descriptions shall be decided in favor of the former.

A. Modularity

Provide components designed for modular increase or decrease of system capability by installation or removal of plug-in modules. Design system components to facilitate modular subassembly and part replacement.

B. Reliability

Provide only new components in current manufacturing production, manufactured to meet requirements specified herein, and free from characteristics and defects which affect appearance, or serviceability or render equipment unsuitable for the intended purpose

C. Maintainability

Components shall be capable of being maintained using commercially available standard tools and equipment. Components shall be arranged and assembled to be readily accessible to maintenance personnel without compromising defeat resistance of ESS.

D. Availability

Provide components designed for continuous operation. Provide solid-state electronic components, mounted on printed circuit boards conforming to UL 796. Boards shall be plug-in, quick-disconnect type. Circuitry shall not be so densely placed as to impede maintenance. Power-dissipating components shall incorporate safety margins of not less than 25 percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity. Light duty relays and similar switching devices shall be solid-state type or hermetically sealed electromechanical. Electrical indicating instruments incorporated into system components shall conform to applicable provisions of ANSI C39.1.

E. Environmental Conditions

1. Interior Conditions

Equipment installed in environmentally protected interior areas shall meet performance requirements specified for the following ambient conditions:

- a. Temperature: 32 to 120 degrees F. Components installed in unheated security protected areas shall meet performance requirements for temperatures as low as zero degrees F;
- b. Pressure: Sea level to 15,000 feet above sea level;
- c. Relative humidity: 5 to 95 percent;
- d. Fungus: Components shall be constructed of nonfungus nutrient materials or shall be treated to inhibit fungus growth; and
- e. Acoustical noise: Components shall be suitable for use in high noise areas above 100 dB, such as boiler rooms, power plants, and foundries without adversely affecting their performance.

2. Exterior Conditions

Components mounted in locations exposed to weather shall be housed in corrosion-resistant enclosures with appropriate environmental protection or be rated for their environment. Component performance shall not degrade because of improper housing design. Components in enclosures shall meet performance requirements when exposed to the following ambient conditions:

- a. Temperature: Minus 25 to 140 degrees F;
- b. Pressure: Sea level to 15,000 feet above sea level;
- c. Solar radiation: Six hours of solar radiation at dry bulb temperature of 120 degrees F including 4 hours of solar radiation at 104 watts per square foot;
- d. Sand and dust: Wind driven for up to 50 miles per hour;
- e. Rain: 2 inches per hour and 5 inches per hour cyclic with wind plus one period of 12 inches per hour;
- f. Humidity: 5 to 95 percent;
- g. Fungus: Warm, humid atmosphere conducive to the growth of heterotrophic plants;
- h. Salt fog: Salt atmosphere with 5 percent salinity;
- i. Snow: Snow loading of 48 pounds per square foot (psf) per hour; blowing snow of 4.6 psf per hour;
- j. Ice accretion: Up to 1/2 inch of radial ice;
- k. Wind: Up to 50 mph with gusts to 66 mph, except that fence sensors shall detect intrusions up to 35 mph; and
- l. Acoustical noise: Components shall be suitable for use in high noise areas above 110 dB, such as flight lines, runup pads, and generator sites without adversely affecting their performance.

F. Surge Protection Devices

Surge protection devices (SPD) are required for the protection, within specified limits, of AC electrical circuits and electronic equipment from the effects of lightning induced voltages, external switching transients and internally generated switching transients.

G. Interchangeability

Like components shall be physically and functionally interchangeable as complete items, without modification of either the original items or of other components with which the items are used.

H. Safety

ESS components shall conform to application rules and requirements of NFPA 70 and applicable UL publications.

I. Test Points

Test points, controls, and other adjustments inside enclosures shall be readily visible and accessible with minimum disassembly of equipment. Test points and other maintenance controls shall not be readily accessible to operator personnel.

J. Component Enclosures

Consoles, annunciator housings, power supply enclosures, sensor control and terminal cabinets, control units, wiring gutters, junction boxes and other component housings, collectively referred to as enclosures, shall be formed and assembled to be sturdy and rigid.

1. Metal Thickness

Thicknesses of metal in cast and sheet metal enclosures of all types shall be not less than those listed in Tables 8.1, 8.2, and 8.3 of UL 1610 for security components, and NEMA ICS 2 and NEMA ICS 6 for other enclosures. Sheet steel used in fabrication of enclosures shall be not less than 16 gauge, except consoles may be 18 gauge.

2. Doors and Covers

Doors and covers shall be flanged. Where doors are mounted on hinges with exposed pins, the hinges shall be of the tight pin type, or the ends of hinge pins shall be tack welded to prevent ready removal. Provide doors having a latch edge length of less than 24 inches with a single lock.

3. Ventilation

Ventilation openings in enclosures and cabinets shall conform to requirements of UL 1610.

4. Mounting

Unless otherwise indicated, sheet metal enclosures shall be designed for wall mounting with top hole slotted. Mounting holes shall be in positions which remain accessible when major operating components are in place and door is open, but shall be inaccessible when door is closed.

5. Labels

Labels shall be affixed to such boxes indicating they contain no connections. These labels shall comply with Division 26.

6. Enclosure Locks

Locks and key-lock-operated switches required to be installed on component enclosures shall be UL listed, round-key type with three dual, one mushroom, and three plain pin tumblers, or shall have a pick resistance equal to a lock having a combination of five cylinder pin and five-point three-position side bar in the same lock. Keys shall be stamped "DO NOT DUP." Locks on components for maintenance access shall be keyed alike; two keys shall be furnished per enclosure for such locks. Deliver keys, tagged with metal tags, accompanied by a manufacturer's certificate which records the number of each key made.

K. Detection Sensors

Sensors shall detect penetration of the facility doors by unauthorized personnel or intruders with a probability of detection (pd) of 0.9 with a 95 percent confidence level and, as applicable, shall conform to UL 639. Unless otherwise specified, required sensor power is plus 12 volts dc.

1. Interior Point Sensors

a. Door protection: Accomplish by one or more of the following:

(1) Standard magnetic switch: The magnetic switch shall be of the design specifically for use in either steel or aluminum frame doors commonly found in commercial building

applications. The magnetic switch shall allow for flush recessed or surface mounting. The magnetic switch shall allow for a gap distance not less than 2 inches when installed in metal framed door(s). Color shall match door frame.

L. Automated Access Control System (ACS)

1. Provide automated Access Control System based upon a modular distributed microprocessor architecture. System shall meet the communications requirements of UL 294 and shall have the capability of controlling electric strikes, door contacts and card readers/keypads. System shall grant or deny access or exit based upon card identification data, as well as time of day and day of week. Decision to grant or deny access or exit shall be based upon authorization for such data to be input at a specific location for the current time period.
2. The ACS primary functions shall be to regulate access through specific doors as shown, and monitor alarm points. The ACS Photo Identification credential creation and production system integrated with the cardholder management system is located at the district level.
3. The ACS components shall support configuration and simultaneous monitoring of multiple access control devices through TCP/IP communication interfaces between the network nodes and the district S2 system. Overall control of the ACS, alarm monitoring, and photo identification shall be through existing hardware and software control at the district level.
4. Network Node

The door control node shall be micro-processor based with all access and I/O decisions to be made by the individual ACU(s). The ACU shall be of modular design which will allow for present security requirements and the capability to expand. All field ACU panels shall be configured to intercommunicate via TCP/IP. The ACU shall be capable of, but not limited to, the following:

- A. The Network Node shall make and manage access control decisions with data provided by the Network Controller, and it shall manage the communication between the Controller and Application blades connected to the system's inputs, outputs, and readers. The Node shall be supplied with 12V DC at a minimum of 5 amps. Each Network Node shall support up to seven Application blades. Communications between the node and Network Controller shall be encrypted and authenticated (SHA-1).
- B. The Application blades shall interface with the Network Controller through the Network Node. The Application blades shall be blade-style circuit cards. There shall be four types of Application blades:
 1. Access Control blade: shall support 2 readers (input devices such as keypads, RFID devices or Biometric readers), 4 supervised inputs and 4 relay outputs.
 2. Supervised Input blade: shall support 8 supervised inputs. Supervised input connectors are 2-pin. The system shall support a wide variety of input supervision types such as: no-resistor, one resistor or two resistor including normally-open circuit and normally-closed circuits.
 3. Relay Output blade: shall support 8 relay outputs. Outputs are form C relay represented by 3-pin connectors. Both normally-open circuit and normally-closed circuit output devices are supported. The relay outputs shall support any output devices that operate on the following maximum electrical ratings: 30 Volts DC or AC, 2.5 Amps inductive or 5.0 Amps non-inductive.
 4. Temperature blade: shall support 8 analog temperature sensor inputs. Temperature range shall be 32° to 158° F (0° to 70° C). Temperature precision within that range shall be ±1.0° F (±0.5° C).

5. Card Reader Access Control Devices

Devices shall be tamper alarmed, tamper and vandal resistant, and solid state, containing no electronics which could compromise the access control subsystem should the subsystem be attacked. Devices shall be surface, semiflush, pedestal, or weatherproof mountable as specified for each individual location. Card readers shall be the proximity type and shall be capable of reading Wiegand proximity Smart Card type access control cards.

6. Request to Exit (REX)

Passive-infrared detector designed for request to exit (REX) applications. REX shall be UL Listed as an access control device under the UL 294. The relay output consists of two Form "C" contacts that can be adjusted to latch from approximately 0.5 sec to 64 sec. The latch time features two modes of operation: resettable (R) and non-resettable (NR). The relay can shall be programmed to fail safe. Mount the REX on the wall and aim and/or mask its pattern for more effective use based on installation needs.

7. Access Control Cards: by District

M. Communications

TCP/IP Communications shall link together subsystems of the ACS. ACS communications links shall be via hardwire Category 6 cable. Provide all necessary patch cords for system interconnection. Common communications interface devices shall be provided throughout the ACS. Sensor to control unit interface shall be by dry relay contact normally open or normally closed, except as specified otherwise.

N. Wire and Cable

Hardwire shall utilize electrical conductor lines. Conductors outside the protected area shall be shielded cable installed in electrical metallic tubing (EMT) as specified in Section 28 05 13 - CONDUCTORS, CABLES AND CONNECTORS FOR ELECTRONIC SAFETY AND SECURITY

2.5 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm (0.125 inch) 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm (one by 2.5 inches) one by 2.5 inches. Lettering shall be a minimum of 6.35 mm (0.25 inch) 0.25 inch high normal block style.

A. Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.6 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

UL 294 and the appropriate installation manual for each equipment type. Components within the system shall be configured with appropriate "service points" to pinpoint system trouble in less than 20 minutes.

A. Cable and Wire Runs

NFPA 70 and Section 28 05 13 Conductors, Cables and Connectors for Electronic Safety and Security and as specified herein. Conduits including flexible metal and armored cable shall terminate in the sensor or device enclosure. Ends of conduit shall be fitted with insulated bushings. Exposed conductors at ends of conduits external to sensors and devices are not acceptable.

B. Soldering

ASTM B32. For soldering electrical connections, use composition Sn60, Type AR or S, for general purposes; use composition Sn62 or Sn63, Type AR or S, for special purposes. When Type S solder is used for soldering electrical connections, flux shall conform to ASTM B32.

C. Galvanizing

Ferrous metal shall be hot-dip galvanized in accordance with ASTM A123/A123M. Screws, bolts, nuts, and other fastenings and supports shall be corrosion resistant.

D. Fungus Treatment

Completely treat system components for fungus resistance. Do not use treated materials containing mercury-bearing fungicide. Treating materials shall not increase flammability of material or surface being treated. Treating materials shall not cause skin irritation or other personnel injury during fabrication, transportation, operation, or maintenance of equipment, or during use of finished items when used for the purpose intended.

E. Conduit

Install all ACS component cabling in conduit in accordance with NFPA 70 and Section 26 03 33 Raceway And Boxes For Electrical Systems.

F. Underground Cable Installation

Underground conductors connecting devices shall be run in conduit.

3.2 ADJUSTMENT, ALIGNMENT, SYNCHRONIZATION, AND CLEANING

Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation or accrued subsequent to installation from other project activities, and prepared for system activation by manufacturer's recommended procedures for adjustment, alignment, or synchronization. Prepare each component in accordance with appropriate provisions of component installation, operations, and maintenance manuals.

3.3 ACS SYSTEM ACCEPTANCE AND TRAINING

A. ACS System Acceptance testing shall be performed as follows;

1. The Owner will be present for final acceptance testing of the system.
2. Prior to the final acceptance test, security contractor shall conduct a complete test of the entire ACS including subsystems and provide the Engineer with a written report.
3. Following completion of the initial testing and correction of any noted deficiencies, conduct a five-day burn-in test, intent of the burn-in test shall be to prove the ACS by placing it in near real operating conditions. During this period the ACS shall be fully functional and programmed such that all points, interfaces, controls, reports, messages, prompts, etc. can be exercised and validated. Record and correct any system anomaly, deficiency, or failure noted during this period. Scheduling of the final acceptance test shall be based on a review of the results of this burn-in test.
4. Deliver a report describing the results of the functional tests, burn-in tests, diagnostics, calibrations, corrections, and repairs including written certification to the Engineer that the installed complete ACS has been calibrated, tested, and is fully functional as specified herein.
5. Prior to the final acceptance test, complete all clean-up and patch work requirements. Security equipment wiring shall be dressed and all areas shall be free of accumulation of waste materials or rubbish caused by operations under the Contract At completion of the Work, remove all waste materials, rubbish, contractor tools, construction equipment, machinery and all surplus materials.
6. Upon written notification from the Contractor that the ACS is completely installed, integrated and operational, and the burn-in testing completed, coordinate with the Owner to conduct a final acceptance test of the entire system at a mutually acceptable time.
7. During the final acceptance test, no adjustments, repairs or modifications to the system shall be conducted without the permission of the Owner.
8. During the course of the final acceptance test, the Contractor shall be responsible for demonstrating that, without exception, the completed and integrated ACS complies with the contract requirements. Physical and functional requirements of the project shall be demonstrated and shown. This demonstration will begin by comparing as-built drawings conditions of the ACS to requirements outlined in this Section, item by item. Following the Section compliance review, ACS equipment will be evaluated.
9. The functionality of the various interfaces between systems will be tested.
10. The installation of all field devices will be inspected. This field inspection will weigh heavily on the general neatness and quality of installation, complete functionality of each device, and compliance with mounting, back box and conduit requirements.
11. All equipment shall be on and fully operational during any and all testing procedures. Provide personnel, equipment, and supplies necessary to perform all site testing. Provide a minimum of two Contractor employees familiar with the ACS for the final acceptance test. One contractor employee shall be responsible for monitoring and verifying alarms while the other will be required to demonstrate the function of each device. Supply at least two radios or portable telephones for use during the test.

12. The Owner and Engineer retain the right to suspend, terminate or reschedule testing at any time when the ACS is found to be incomplete or fails to perform as specified. In the event that it becomes necessary to suspend, terminate or reschedule the test, all of the Owner and Engineers fees and expenses related to the test shall be deducted from the Contractor's retainage. In the event it becomes necessary to suspend, terminate or reschedule the test, the Contractor shall work diligently to complete and/or repair all outstanding items as required by the Contract Documents. The Contractor shall supply the Owner and Engineer with a detailed punch list completion schedule outlining task-by-task completion dates and a tentative date for a subsequent retest. During the final acceptance test, no adjustments, repairs or modifications to the system shall be conducted without the permission of the Engineer and Owner.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS

3.5 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

END OF SECTION 28 20 00

DIVISION 28 – ELECTRONIC SAFETY & SECURITY
SECTION 28 31 64
FIRE DETECTION & ALARM SYSTEM, ADDRESSABLE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.41 (1990; R 2008) Audible Emergency Evacuation Signal (ASA 96)

FM GLOBAL (FM)

FM APP GUIDE (updated on-line) Approval Guide
<http://www.approvalguide.com/>

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1 (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

IEEE C62.41.2 (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1 (2015) National Fire Code.

NFPA 13 - (2013) Standard for the Installation of Sprinkler Systems.

NFPA 1221 (2013) Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems

NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

NFPA 72 (2013) National Fire Alarm and Signaling Code

NFPA 90A (2015) Standard for the Installation of Air Conditioning and Ventilating Systems

NFPA 101 - 2009 Life Safety Code.

UNDERWRITERS LABORATORIES (UL)

UL 1242 (2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel

UL 1971 (2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired

UL 228	(2006; Reprint Nov 2008) Door Closers-Holders, With or Without Integral Smoke Detectors
UL 268	(2009) Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Oct 2014) Smoke Detectors for Duct Application
UL 38	(2008; Reprint Nov 2013) Manual Signaling Boxes for Fire Alarm Systems
UL 464	(2009; Reprint Apr 2012) Standard for Audible Signal Appliances
UL 521	(1999; Reprint May 2010) Heat Detectors for Fire Protective Signaling Systems
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel
UL 797	(2007; Reprint Dec 2012) Electrical Metallic Tubing – Steel
UL 864	(2003; Reprint Aug 2012) Standard for Control Units and Accessories for Fire Alarm Systems

1.2 SYSTEM DESCRIPTION

The fire detection and alarm system and the central reporting system shall be a complete, supervised fire alarm reporting system configured in accordance with NFPA 72; exceptions are acceptable as approved by the engineer. Furnish equipment compatible and UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

A. Operation

1. Activate the system into the alarm mode by actuation of any alarm initiating device. The system will remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm and supervisory initiating devices shall be individually addressable. Alarm initiating devices shall be connected to initiating device circuits in accordance with NFPA 72. Connect alarm notification appliances to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. Provide a looped conduit system so that if the conduit and all conductors within are severed at any point, all IDC, NAC and SLC will remain functional. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and shall provide the following features:
 - a. Sufficient memory to perform as specified and as shown for addressable system.
 - b. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and appliances missing/failed remote detector - sensitivity adjustment from the panel for smoke detectors.
 - c. Capability of each addressable device being individually disabled or enabled from the panel.

- d. Size each SLC to provide 40 percent addressable expansion without hardware modifications to the panel.

B. Operational Features

The system shall have the following operating features:

- a. Monitor electrical supervision.
- b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.
- c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.
- d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.
- e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.
- f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD displays on the control panel nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.
- g. Electrical supervision for circuits used for supervisory signal services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.
- h. Confirmation or verification of all smoke detectors. The control panel shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices other than smoke detectors shall be programmed without confirmation or verification.
- i. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided. Coordinate with HVAC Contractor.
- j. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.

- k. The fire alarm control panel shall monitor the fire sprinkler system, or other fire protection extinguishing system.
- l. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.
- n. Zones shall be as determined by the system manufacturer.

C. Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

- a. Transmission of signals over the station telephonic fire reporting system. The signal shall be common for any device.
- b. Visual indications of the alarmed devices on the fire alarm control panel display and on the remote audible/visual display.
- c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ASA S3.41.
- d. Deactivation of the air handling units above 2000 cfm.
- e. Shutdown of power to the data processing equipment in the alarmed area.
- f. Automatic discharge of the designated fire suppression systems. A 15 second maximum delay shall be provided for the deluge system, a 30 second delay for the wet pipe system.

D. Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

E. Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

F. Interface with other Equipment

Interfacing components shall be furnished as required to connect to subsystems or devices which interact with the fire alarm system, such as supervisory or alarm contacts in suppression systems, operating interfaces for smoke control systems, door releases, etc. Contractor shall provide all necessary devices for building operations. Coordinate.

1.3 SUBMITTALS

Submit the following:

Shop Drawings

Detail Drawings

Detail drawings, prepared and signed by a NICET Level 4 Fire Alarm Technician, as specified.

Product Data

Storage Batteries

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Low Battery Voltage

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Special Tools and Spare Parts

Spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Technical Data and Computer Software

Technical data which relates to computer software.

Training

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated Owner personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

Test Reports

Testing

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls.

Include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

Certificates

Equipment

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Qualifications

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

Operation and Maintenance Data

Operating and Maintenance Instructions

Three copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training.

1.4 QUALITY ASSURANCE

A. Qualifications

1. Technician

- a. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

2. Installer

The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 4 Fire Alarm Technician shall supervise the installation of the fire alarm system. NICET Level 2 or higher Fire Alarm Technician shall install and terminate fire alarm devices, cabinets and panels. An electrician or NICET Level 1 Fire Alarm Technician shall install conduit for the fire alarm system. Fire Alarm Technicians to perform the installation of the system. A Fire Alarm Technician with a minimum of 4 years of experience shall perform/supervise the installation of the fire alarm system. Fire Alarm Technicians with a minimum of 2 years of experience shall be utilized to assist in the installation and terminate fire alarm devices, cabinets and panels. An electrician shall be allowed to install wire or cable and to install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment

shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

B. Detail Drawings

Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical audible appliances. Check the layout based on the actual audible devices to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

- A. Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered to owner. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:
1. Identification of programmable portions of system equipment and capabilities.
 2. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
 3. Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.
 4. Description of Fire Alarm Control Panel equipment operation.
 5. Description of auxiliary and remote equipment operations.
 6. Library of application software.
 7. Operation and maintenance manuals as specified in SD-19 of the Submittals paragraph.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

1.7 SPECIAL TOOLS AND SPARE PARTS

Furnish to the Owner, software, connecting cables, proprietary equipment and two spare fuses of each type and size required, necessary for the maintenance, testing, and reprogramming of the equipment. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Mount spare fuses in the fire alarm panel.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

Existing system and devices are Simplex; replacement panel and devices must be compatible with the existing system.

2.2 NAMEPLATES

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

2.3 CONTROL PANEL

All devices shall be compatible with the new Simplex 4100ES Fire Alarm Control Panel and shall comply with the applicable requirements of UL 864.

A. Circuit Connections

Connect circuit conductors entering or leaving the panel to screw-type terminals with each conductor and terminal marked for identification.

B. System Expansion and Modification Capabilities

Provide, as part of this contract, any equipment and software needed by qualified technicians to implement the changes to the fire alarm system.

C. Addressable Control Module

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled.

D. Addressable Initiating Device Circuits Module

Configure the initiating device being monitored as required for an initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling. The module shall be UL listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED.

2.4 REMOTE ANNUNCIATOR(S)

A. LCD Mimic Panel

Where shown on the plans, provide and install an LCD annunciator. The annunciator(s) shall have a beige enamel trim housing covering a membrane keypad complete with the following:

1. Two line by 40 character LCD display.
2. Information transmitted over one twisted shielded pair of wire and operating power shall be 24VDC and be fused or power limited at the control panel.
3. Control switches for system, acknowledgments, alarm silence and system reset.
4. Lamp/LCD test button.
5. Backlit display.
6. Four programmable control switches.
7. Surface or flush mount on a standard 6-gang electrical box.
8. Maximum size 300mm wide x 114mm high x 80mm deep.
9. A key "Enable" switch shall be provided to activate or de-activate the control switches.
10. Tone Alert - to duplicate the control panel tones during Alarm and Fault conditions.
11. Led indications for Alarm, Isolate, Fault, Alarm Silence and Power.

B. The LCD mimic panel shall have the ability to scroll through the list of alarms, faults and isolates as per the FIP, the display shall provide clear English language information.

C. Equivalent to a Simplex 4603-9101.

2.5 STORAGE BATTERIES

Provide storage batteries which are 24 VDC sealed, lead-calcium type requiring no additional water with ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Locate batteries at the bottom of the panel. Provide batteries with over-current protection in accordance with NFPA 72.

2.6 BATTERY CHARGER

Battery charger shall be completely automatic, 24 VDC with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Locate charger in control panel cabinet.

2.7 ADDRESSABLE MANUAL FIRE ALARM STATIONS

Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on surface mounted outlet boxes. Manual stations shall be mounted at 48 inches. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations.

2.8 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated. Installed devices shall conform to NFPA 70 hazard classification of the area where devices are to be installed.

A. Carbon Monoxide Detectors

1. Addressable CO Sensor

- a. The CO Sensor shall be an addressable carbon monoxide (CO) sensing module providing both CO toxic gas detection and enhanced fire detection, and shall be listed to UL 268, Smoke Detectors for Fire Alarm Signaling Systems and UL 2075, Gas and Vapor Detectors and Sensors; allowing systems to be listed to UL 2034, Single and Multiple Station Carbon Monoxide Alarms. Units shall be installed per NFPA 720.
- b. The CO Sensor shall include CO sensor element mounted in the sensor base which can be easily replaced without replacing the complete sensor base assembly.
- c. The CO Sensor base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
- d. The CO Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.

- e. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
- f. The CO Sensor shall provide a 10 year life expectancy before replacement is necessary or required.
- g. The CO Sensor base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.

2. Addressable CO Sensor Sounder Base

- a. The CO Sensing element shall support operation with a Sounder base; the CO Sensor Sounder base shall provide temporal code 3 (TC3) for fire, or temporal code 4 (TC4) for toxic carbon monoxide alarms.
- b. The CO Sensor Sounder base shall be listed to UL464, Audible Signal Appliances.
- c. CO sensor shall provide enhanced fire detection with the addition of two selectable modes of operation: Nuisance Alarm Reduction Mode and Faster Fire Detection.
- d. The CO Sensor Sounder Base shall include CO sensor element mounted in the sounder base which can be easily replaced without replacing the complete sensor base assembly.
- e. The CO Sensor Sounder base shall provide address selection in the base allowing the address to remain with its location when the sensor is removed for service or type change.
- f. The CO Sensor Sounder Sensor base shall include an integral red LED to indicate the power-on, trouble, test mode or alarm status.
- g. The CO Sensor Sounder base shall report the following CO Sensor troubles: Communication loss, Disabled, Almost Expired 12 Months, Almost Expired 6 Months, Expired (End of Life), and Sensor Missing/Failed.
- h. The CO Sensor Sounder Base shall be interchangeable with the CO Sensor 520 Hz Sounder Base.

3. Duct Carbon Monoxide Detector

- a. 4 Wire conventional duct mounted detector; SAEVU Model SL-701 Series.
- b. Provide MSR-50/CO remote test station and audio-visual alarm.
- c. Provide Simplex model 4090-9101 communicating zone adapter module.

B. Smoke Detectors

Design smoke detectors for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.

1. Ionization Detectors

Ionization detectors with a dual chamber shall be responsive to both invisible and visible particles of combustion. One chamber shall be a reference chamber and the second a sampling chamber. Detectors containing radium shall not be provided. Detectors shall not cause an alarm condition due to anticipated fluctuations in relative humidity. The sensitivity of the detector shall be field adjustable to compensate for operating conditions. Detector shall require no replacement or readjustment to restore it to normal operation after an alarm condition. Each detector shall be capable of withstanding ambient air velocity up to 300 fpm in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

2. Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

3. Duct Detectors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 6 feet and those mounted below 6 feet that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Test switches shall be wall mounted near the detector at 60" AFF to allow for easy access. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility. Coordinate with HVAC Systems Contractor.

C. Combination Smoke and Heat Detectors

Combination smoke and heat detectors shall have an audible device (self-contained) and be designed for detection of abnormal smoke densities by the photoelectric principle and abnormal heat by a fixed temperature sensor. Smoke detectors shall be provided with an LED light source. Failure of the LED shall not cause an alarm condition and the sensitivity shall be factory set at a nominal 3 percent and require no field adjustments of any kind. Heat detector portion shall be fixed temperature sensor rated at 135 degrees F. The audible appliances shall have a minimum sound output of at least 85 dBA at 10 feet. Detectors shall contain a visible indicator LED that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure.

2.9 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red.

A. Alarm Horns

Horns shall be surface mounted, with the matching mounting back box surface mounted and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least 85 dBA at 10 feet. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

B. Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 15 candela. Strobe shall be surface mounted.

C. Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Architect/Engineer.

2.10 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

A. Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

B. Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The SLC wiring shall be fiber optic or copper cable in accordance with the manufacturer's requirements. Wiring for fire alarm dc circuits shall be No. 14 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field and advise the Architect of any discrepancy before performing the work.

3.2 INSTALLATION

Install all work as shown, in accordance with NFPA 70, NFPA 72, NFPA 720 and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

A. Power Supply for the System

Provide a single dedicated circuit connection for supplying power from a branch circuit to each building fire alarm system. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

B. Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

C. Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each new or existing detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided. Detectors installed in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD in a finished, visible location.

D. Notification Appliances

Notification appliances shall be mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.

E. Addressable Initiating Device Circuits Module

The initiating device circuits module shall be used to connect supervised conventional initiating devices (water flow switches, water pressure switches, manual fire alarm stations, high/low air pressure switches, and tamper switches). The module shall mount in an electrical box adjacent to or connected to the device it is monitoring and shall be capable of Style B supervised wiring to the initiating device. In order to maintain proper supervision, there shall be no T-taps allowed on style B lines. Addressable initiating device circuits modules shall monitor only one initiating device each. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform supervisory and alarm functions as specified in NFPA 72, as indicated on the drawings and as specified herein.

F. Addressable Control Module

Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. If a supplementary suppression releasing panel is provided, then the monitor modules shall be mounted in a common enclosure adjacent to the suppression releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices. All interconnecting wires shall be supervised unless an open circuit or short circuit abnormal condition does not affect the required operation of the fire alarm system. If control modules are used as interfaces to other systems, such as HVAC, they shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits. Control modules that connect to devices shall supervise the notification appliance circuits. Control modules that connect to auxiliary systems or interface with other systems (non-life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform required alarm functions as specified NFPA 72, as indicated on the fire protection drawings and as specified herein.

3.3 OVERVOLTAGE AND SURGE PROTECTION

A. Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

B. Low Voltage DC Circuits Surge Protection

All communication cables/conductors, except fiber optics, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

C. Signal Line Circuit Surge Protection

All SLC cables/conductors, except fiber optics, shall have surge protection/isolation circuits installed at each point where it exits or enters a building. The circuit shall be protected from surges in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. The surge protector/isolator shall be rated to protect the equipment.

3.4 GROUNDING

Grounding shall be provided by connecting to building ground system.

3.5 TRAINING

Provide training course for the operations and maintenance staff. Conduct the course in the building where the system is installed or as designated by the Owner. The training period for systems operation shall consist of 1 training day (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions. In addition, training shall be provided on performance of expansions and modifications to the fire detection and alarm system. The training period for system expansions and modifications shall consist of at least 1 training day (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests.

3.6 TESTING

Notify the Owner at least 10 days before the preliminary and acceptance tests are to be conducted. Perform the tests in accordance with the approved test procedures in the presence of the Owner's representative. The control panel manufacturer's representative shall be present to supervise tests. Furnish instruments and personnel required for the tests.

A. Preliminary Tests

Upon completion of the installation, subject the system to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. Conduct the megger test prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing complete and submit the NFPA 72, Certificate of Completion and Testing Form.

B. Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Conduct testing in accordance with NFPA 72. The recommended tests in NFPA 72 are considered mandatory and shall verify that previous deficiencies have been corrected. The Fire alarm Technician supervising the installation of the fire alarm system shall attend the testing of the system. The test shall include all requirements of NFPA 72 and the following:

1. Test of each function of the control panel.
2. Test of each circuit in both trouble and normal modes.
3. Tests of each alarm initiating devices in both normal and trouble conditions.
4. Tests of each control circuit and device.

5. Tests of each alarm notification appliance.
6. Tests of the battery charger and batteries.
7. Complete operational tests under emergency power supply.
8. Visual inspection of wiring connections.
9. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
10. Ground fault.
11. Short circuit faults.
12. Stray voltage.
13. Loop resistance.

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DIVISION 31 – EARTHWORK

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 earth moving work consisting of:
 - 1. Excavation for footings and foundations.
 - 2. Rough grading for new pads and stoops on grade.
 - 3. Removal of unsatisfactory material below rough grade and subgrade levels as required.
 - 4. Provision of granular materials from offsite for structural fill as required.
 - 5. Classifying and stockpiling usable excavated material, on site, for re-use.
 - 6. Preparation of subgrades to receive fills.
 - 7. Filling, backfilling and compaction of fills.
 - 8. Finish grading of disturbed site areas.
 - 9. Removal of excess excavated materials.
- B. Related Requirements:
 - 1. Bid Form: Unit pricing or removal of unsuitable soil and compaction of engineered fill.
 - 2. Section 033000 "Cast-In-Place Concrete" for cast-in-place concrete work.

1.3 COORDINATION

- A. Coordinate earth moving work for building with civil earthwork.

1.4 SUBMITTALS

- A. Process all submittals per requirements in Section 013300 – Submittal Procedures.
- B. Submit to the Soil Testing Service 50 pound representative samples of each proposed fill material at least 2 days prior to the start of any filling operation.
- C. The Soil Testing Service shall submit 2 copies of all test reports to Owner's Representative.

1.5 QUALITY ASSURANCE

A. Soil Testing and Inspection Service:

1. The Contractor shall engage the services of an independent soils testing service, approved by Owner, to test in-place foundation soils and other soil materials proposed for use in the Work.
2. Costs for the first testing of an area shall be paid for by the Owner. All testing required for checking and correcting faulty work or work to be re-done shall be paid for by the Contractor at his own expense.
3. Services shall include:
 - a. Observation of proofrolling.
 - b. Sieve analysis of material to be used for compacted fill beneath footings and for fill beneath concrete slabs in exterior areas.
 - c. Tests for maximum dry density of compacted fill materials.
 - d. In-place field dry density tests for every 2,500 square feet of area of each layer of compacted subgrade fill under building slabs, other than drainage fill, as directed by Owner's Representative.
 - e. In-place field dry density tests, per ASTM D 1556 or ASTM D 2922 and D3017, for each layer of compacted fill under all footings, as directed by Owner's Representative.
 - f. If compaction is found to be unsatisfactory, extra in-place field dry density tests to determine the extent of recompaction work required.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

- ### A. Existing Conditions:
- The excavation contractor shall visit the site prior to submitting his bid in order to determine the existing conditions under which he will be obliged to operate and the extent of the site preparation work required.
- ### B. Existing Utilities:
1. Locate existing underground utilities in the areas of work before starting earthwork operations. If utilities are to remain in place, provide adequate means of protection during earthwork operations.
 2. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the Owner's Representative immediately as to how to proceed.
 3. Do not interrupt existing utilities serving facilities occupied or used by the Owner or others, except when permitted in writing by the Owner's Representative and then only after acceptable temporary utility services have been arranged.
 4. Demolish and completely remove from the site underground utilities indicated to be removed. Coordinate with local utility companies for shut-off and capping or sealing of services if lines are active.
- ### C. Explosives:
- The use of explosives will not be permitted.

1.8 PROTECTION OF PERSONS AND PROPERTY

- A. Barricade open excavations made as a part of earthwork operations and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
- B. Protect benchmarks and existing structures, roads, sidewalks, paving and curbs against damage from vehicular or foot traffic.
- C. Protect from frost the bottoms of excavations and soils around and beneath foundations.

1.9 BRACING, SHEETING AND SHORING

- A. Provide bracing, sheeting and shoring for the sides of excavations as necessary to prevent movement or settlement of adjacent structures, utilities, roads and streets, etc. The cost of bracing, sheeting and shoring required shall be deemed to have been included as part of the Contract Sum.
- B. The Contractor shall be entirely responsible for the strength and adequacy of all such bracing, sheeting and shoring, and is liable for any damage or injury caused by or resulting from improperly supported soils and structures. He shall, if required, submit fully detailed Shop Drawings for review prior to placement; however, such review shall not diminish the Contractor's responsibilities in any way.
- C. The Contractor shall issue any notices to owner of adjoining property that may be required by any pertinent laws or ordinances. Furnish copies of such notices to Owner's Representative.
- D. If the safety of any adjacent structures, utilities, etc., shall appear to be endangered, take all proper means to support such embankments, structures, utilities, etc., and notify the Owner. Do not resume operation without the Owner's permission.
- E. Provide and place bracing and shoring ordered by the Owner when necessary to safeguard adjacent buildings, etc. If the Contractor fails to comply promptly when so ordered, the required bracing and shoring may be placed by order of the Owner at the Contractor's expense. Any such action shall not relieve the Contractor of responsibility for the bracing and shoring or liability for damage.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Fill Materials: Shall be obtained from excavations on the site, provided the material meets the following requirements and is approved by the testing lab. Fill material from offsite shall be obtained from borrow pits approved by the testing lab.
- B. Fill Supporting Footings: Well graded granular material, sand or gravel, tested by the testing laboratory. Not more than 10% shall pass #200 sieve; except that fill placed during wet weather or in wet areas shall have no more than 5% passing #200 sieve. Cohesive soils from excavations on the site may be used provided they can be compacted to 95% of maximum density as determined by ASTM D 1557-78.

- C. Fill Under Interior Floor Slabs, UP TO Drainage Course: Granular material of friable earth, or clay of low plasticity, tested by the testing laboratory.
- D. Drainage Fill Directly Under Interior Floor Slabs: Natural hard, clean sand; or naturally or artificially graded mixture of crushed gravel or crushed stone acceptable to the Owner's Representative and the testing service.
- E. Fill Under Concrete Pads and Stoops: Granular fill, the same as used for footings.
- F. Other (Ordinary) Backfill and Fill: Reasonably uniform soil materials free of organic or frozen material, debris, trash, and of stones 4" or greater in diameter. Soils from excavations on site may be used provided they can be compacted to the densities specified.

PART 3 - EXECUTION

3.1 SITE CLEARING

- A. General:
 - 1. Except as otherwise indicated, remove trees, shrubs, grass, weeds and other vegetation, improvements, or obstructions that directly interfere with installation of new construction. Remove tree stumps and remove roots projecting above surface of finish grade.
 - 2. Carefully and cleanly cut roots and branches of trees indicated to be left standing, where such roots and branches obstruct facilities to be constructed. Do not remove branches and roots for the convenience of construction operations except as approved by Owner for each tree. After cutting branches and roots, immediately apply an approved wound dressing.
- B. Topsoil Removal: Strip topsoil from areas to be excavated for construction. Remove heavy growths of grass from areas before stripping.
 - 1. Remove topsoil down to subsoils.
 - 2. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance from such trees to prevent damage to the main root system.
 - 3. Topsoil which has been removed without intermingling with other soils and is reasonably free of clay lumps, stones, and other objects over 2" in diameter, and without weeds, roots, and other objectionable material, shall be stockpiled for completion of the work. Topsoil not meeting these criteria may only be used for landscape work and shall be stockpiled separately or removed from the site.
 - 4. Construct stockpiles so as to drain precipitation freely. Cover storage piles as required to prevent wind-blown dust and erosion.

3.2 WATER CONTROL

- A. Grade around excavated areas so as to prevent water from running into trenches, areas for slabs-on-grade and excavations; and grade so as to prevent water from running onto adjacent properties or public thoroughfares.

- B. Keep excavations dry with pumps, piping and temporary drains until backfilling is completed.
- C. Do not discharge drainage water lines into municipal sewers without municipal approval.
- D. Ensure that water discharge does not contain silt.

3.3 EXCAVATION

- A. General: Excavate for all work to elevations and dimensions indicated, plus sufficient space to permit erection and installation of forms for footings and foundation walls.
 - 1. Notify testing lab and Owner of all unexpected sub-surface conditions. Discontinue work in area until Owner provides notification to resume work.
- B. All subgrades for footing and building slabs shall be approved by the soils testing service. Give soils testing service adequate notice as to when excavations are scheduled to reach subgrade elevations shown on Drawings.
- C. Authorized Additional Excavation: If an unacceptable subgrade material is encountered at the subgrade elevation shown on the Drawings, the Owner may direct the Contractor to excavate to a greater depth by way of Change Order.
- D. Unauthorized Excavations: If an acceptable subgrade is encountered at the subgrade elevation shown on the Drawings and excavation goes to a greater depth, no additional payment shall be made by the Owner for such excavation nor for backfilling to repair the over excavation.
- E. Rock Excavation:
 - 1. Definition: Excavation of boulders or pieces of rock, concrete, or masonry measuring more than 1/2 cubic yard; or hard shale or solid ledge rock and masonry requiring continuous use of pneumatic tools or drilling to be removed.
 - 2. Contractor must demonstrate inability to remove by hand pick or by power excavator used for other excavation. Prior to removal, obtain written approval from Owner's Representative that material to be removed qualifies for extra payment.
- F. Protect footing and building slab excavations from freezing until excavations are completely backfilled.

3.4 FILLING AND COMPACTION

- A. General:
 - 1. Remove all debris from excavations before backfilling.
 - 2. No fill to be compacted shall be placed in free water, or on frozen ground.
 - 3. Manipulate and wet the fill materials as required to obtain uniform moisture content throughout. Fills shall be placed at +2% of the material's optimum moisture content. Mix lean to fat clays with lower plasticity clays and/or hydrated lime or lime byproduct materials as necessary to achieve required compaction values.

4. Prior to placement of fills under footings, slabs and pavings, the upper 12" of subgrade shall be brought to within 2% of optimum moisture and compacted to not less than 90% per Modified Proctor Method.
5. All subgrades shall be approved by the soils testing service just prior to placement of fills. Should subgrade become frozen, desiccated, saturated or disturbed, remove the affected material, or scarify, moisture condition and recompact the affected materials. Notify soils testing service well ahead of when excavations are scheduled to reach the subgrade elevations required.
6. Proofroll after placement of fill to verify compliance.

B. Placing Fill to be Compacted:

1. **Placement:** Place fill material in layers not exceeding 8" in thickness, starting in the deepest area and progressing approximately parallel to the finished grade.
2. **Testing Between Layers:** Compaction of each layer shall be tested as specified. Obtain approval from Owner's Representative before next layer of fill is started.
3. **Drainage Course Under Interior Concrete Slabs On Grade:** Install a layer of the specified granular fill 6" thick, such that, after compaction, the top of the fill will be at the bottom elevation of the slab as indicated by the Drawings, plus 0", minus 1/2".
4. **Fill Under Exterior Platform Slabs:** Extend granular fill down to bottom of platform foundation.

C. Compaction Procedures:

1. Compact the soils immediately after placement, while they retain their optimum moisture content; otherwise, manipulate and wet the soil as required to obtain the required moisture content uniformly throughout.
2. Suspend compaction operations when proper results cannot be obtained because of rain or soggy conditions, or when other conditions are unsatisfactory.
3. Compact with vibratory compaction and/or rolling equipment to the specified densities. Compaction by travel of grading equipment will not be considered adequate. Use small vibratory or hand tamping compactors whenever fill is placed adjacent to walls or around footings and columns.
4. Each layer of fill shall be compacted all across its surface to the required density before additional fill may be placed.
5. If compaction is found to be unsatisfactory, recompact until required density is achieved.

D. Compaction Densities:

1. **Granular Fill Under Footings, Building Slabs and Exterior Platforms:** 95% of maximum density, per Modified Proctor Test (ASTM D 1557).
2. **Cohesive Soil Fills Within Perimeter of Building Foundations:** 95% of maximum laboratory density, per Modified Proctor Test (ASTM D 1557).
3. **Fills To 10 Feet Outside of Building Perimeter:** 95% of maximum density, per Modified Proctor Test (ASTM D 1557).

- E. Replacement of Over-Excavation: Refer to Bid Form for unit pricing or removal of unsuitable soil and compaction of engineered fill
1. Where over-excavation has been authorized, provide approved granular fill to replace the materials excavated from below the designated design subgrade and compact the fill to the required densities. Payment for such additional work will be in accordance with the established unit prices.
 2. When authorized over-excavation causes the width of the excavation to be increased, fill the excavation to the extended width with the appropriate fill materials and compact the fill to the required densities. Payment for the additional fill work required will be in accordance with the established unit prices.
 3. Where over excavation has not been authorized, fill with granular fill compacted to the required density at the required elevation without additional payment.

3.5 ROUGH GRADING

- A. General: Uniformly grade new filled areas, including adjacent transition areas, and as otherwise indicated within the limits of construction. Include any areas disturbed by construction operations.
1. Smooth the finished surfaces within specified tolerances, with uniform levels of slopes between points where elevations are shown, or between such points and existing grades.
 2. The degree of finish required will be that ordinarily obtainable from either blade-grader or scraper operations.
- B. Walks: Shape the surface of areas under walks to line, grade and cross-section, with the finish surface not more than 0.00' above nor 0.10' below the required subgrade elevation, after compaction, and graded to prevent ponding of water after rains.
- C. Interior of Building: Rough grade the areas under slabs-on-grade to not less than 6" nor more than 6-1/2", plus the slab thickness, below finish floor line. Grade the surface so as to be free from irregular surface changes.

3.6 MAINTENANCE

- A. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.
- B. Protection of Graded Areas: Protect newly graded areas from traffic and erosion, and keep free of trash and debris.
1. Repair and re-establish grades in settled, eroded, and rutted areas to the specified tolerances.
 2. Any settlement of areas shall be filled level and smoothed out, and shall be repaired so as to maintain the required grade level for a period of one year.

3.7 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Remove excavated material unsuitable for fill or backfill from Owner's property before backfill operations begin. After backfilling is completed, remove from Owner's property all excess fill material.
- B. Areas under stockpiles not indicated as receiving new construction shall be restored to original condition.
- C. All off-site hauling shall be in tight beds such as to prevent spilling onto streets or highways. Use drip pans where necessary to prevent spilling. Off-site haul routes shall be approved by the appropriate county and city authorities for disposal of wastes from this contract.
- D. All excess material removed from site shall become the property of the Contractor. Legally dispose of all materials removed from the site.

END OF SECTION 312000



Rockford, Illinois

TESTING SERVICE CORPORATION

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November 20, 2015

Richard L. Johnson Associates, Inc.
Attn: Mr. Scott R. Johnson, AIA, LEED AP
4703 Charles Street
Rockford, Illinois 61108

RE: L-83,579
Proposed Cafeteria Building Addition
Lewis Lemon Elementary School
1993 Mulberry Street
Rockford, Illinois

Dear Mr. Johnson:

Enclosed please find three (3) copies of our Soils Exploration Report prepared for the referenced project. A copy of the report has also been forwarded to you via e-mail. The invoice covering these geotechnical services will be sent under separate cover.

It has been a pleasure to assist you with this work. Please call if there are any questions or if we may be of further service.

Respectfully submitted,

TESTING SERVICE CORPORATION

Jeffrey L. Martin, P.E.
Rockford Branch Manager

JLM/rb

Enc. 3 Reports



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Geotechnical & Environmental Engineering



Construction Materials Engineering & Testing



Laboratory Testing of Soils, Concrete & Asphalt



Geo-Environmental Drilling & Sampling

Report of Soils Exploration

Proposed Cafeteria Building Addition

Lewis Lemon Elementary School

1993 Mulberry Street

Rockford, Illinois

**Richard L. Johnson
Associates, Inc.**

4703 Charles Street

Rockford, Illinois 61108

GEOTECHNICAL GROUP
ROCKFORD

November 20, 2015

L - 83,579

REPORT OF SOILS EXPLORATION
PROPOSED CAFETERIA BUILDING ADDITION
LEWIS LEMON ELEMENTARY SCHOOL
1993 MULBERRY STREET
ROCKFORD, ILLINOIS

PREPARED FOR:
RICHARD L. JOHNSON ASSOCIATES, INC.
4703 CHARLES STREET
ROCKFORD, ILLINOIS 61108

PREPARED BY:
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November 20, 2015

L - 83,579

REPORT OF SOILS EXPLORATION
PROPOSED CAFETERIA BUILDING ADDITION
LEWIS LEMON ELEMENTARY SCHOOL
1993 MULBERRY STREET
ROCKFORD, ILLINOIS

1.0 INTRODUCTION

This report presents results of the Soils Exploration performed for the proposed Lewis Lemon Elementary School Cafeteria Building Addition. These geotechnical services are provided in general accordance with Testing Service Corporation's (TSC) Proposal Number 55,088 Revised, dated June 23, 2015, and the attached General Conditions, incorporated herein by reference.

It is understood that the project will include the construction of a new addition to the existing Lewis Lemon Elementary School, located at 1993 Mulberry Street in Rockford, Illinois. The existing school building was constructed in 1993, as we understand it. The addition will be approximately 3,000 square feet in size and will extend off the north side of the east wing of the existing school building. It is further understood that the existing school building is generally a one story, slab-on-grade structure, with the exception of the east wing, which contains a basement or lower level below the first floor. The basement or lower level of the east wing of the existing school is at grade on the east side. The addition will have a cafeteria and will be of single story, slab-on-grade design. It is anticipated that the structure will have masonry bearing walls with a steel framework.

No information regarding foundation or floor loads were provided to us. For purposes of this report, it is assumed that any column loads will not exceed approximately 50 kips, while wall loads will be on the order



of 7 kips per lineal foot (klf) or less. It is understood that Finished Floor (FF) Elevation for the addition will match the Finished (First) Floor of the existing school building. For purposes of this report, we have arbitrarily assigned a FF Elevation of 100.0.

A new parking lot expansion is planned as part of this project. The existing parking lot, located just west of the existing school building and on the east side of Albert Avenue, will be expanded to the north.

The results of field and laboratory testing and recommendations based upon these data are included in this report. Specifically addressed are building foundations, mass-grading, floor slabs and pavements.

2.0 SITE DESCRIPTION

The proposed building addition will be in a parking lot pavement area, located on the east side of the existing Lewis Lemon Elementary School near the northeast corner of the existing building. The proposed west parking lot expansion will be located in a grassy/lawn area on the west side of the existing school and the east side of Albert Avenue. Sunset Park is located immediately to the east of the Lewis Lemon Elementary School site, while mostly residential properties are located in the general vicinity surrounding the school property and beyond the park. Downtown Rockford and the Rock River are located approximately 1 mile to 1¼ miles to the east of the site.

The school site slopes from the west end of the site at Albert Avenue down to the east school property line at Sunset Park. The building addition area slopes down slightly to the north, with total relief at the test locations on the order of 2.2 feet. Existing grade at the test locations in the area of the proposed addition varies from 0.6 to 2.8 feet below the assumed FF Elevation of 100.0. Existing grade at the test location (Boring 5) located on the west side of the school, in the area of the proposed parking lot expansion, is nearly 10.5 feet above the Finished (First) Floor (assumed Elevation 100.0) of the school.



3.0 FIELD EXPLORATION AND LAB TESTING

A total of five (5) soil borings, numbered 1 through 5, were performed by TSC for the project. The borings were drilled at or near to the locations shown on the attached Boring Location Plan. Borings 1-4 were made in the area of the proposed building addition, while Boring 5 was made in the proposed west parking lot expansion area. The boring locations were staked in the field by representatives of TSC. An aerial site plan prepared and provided to us by Richard L. Johnson Associates, Inc., was used and reproduced for purposes of preparing a Boring Location Plan. Reference is made to the Boring Location Plan in the Appendix for the drilling layout.

TSC estimated the ground surface elevation at each boring location by conventional differential leveling methods using the Finished (First) Floor of the existing building as benchmarks at doors marked "Q" for Borings 1-4 and "D" for Boring 5. The benchmarks were arbitrarily assigned an elevation of 100.0. The ground surface elevation for each boring is shown on the boring logs, as well as on the Boring Location Plan, in the Appendix of this report.

Borings 1-4 were each drilled to a depth of 30 feet below existing grade, while Boring 5 was extended to a depth of 7.5 feet below existing grade. Drilling and sampling procedures were in general accordance with currently recommended American Society for Testing and Materials specifications. Soil sampling was generally performed at 2½-foot depth intervals to a depth of 15 feet and at 5-foot depth intervals below 15 feet. The samples were taken in conjunction with the Standard Penetration Test, for which driving resistance to a 2" split-spoon sampler (N value in blows per foot) provides an indication of the relative density of granular materials and consistency of cohesive soils. Water level readings were taken during and following completion of drilling operations.

Soil samples were examined in the laboratory to verify field descriptions and to classify them in accordance with the Unified Soil Classification System. Laboratory testing included moisture content determinations for all cohesive and intermediate (silt or loamy) soil types. An estimate of unconfined compressive strength was obtained for all inorganic native clay soils using a calibrated pocket penetrometer, and direct methods were also used on some clay samples. Dry unit weight tests were performed on select samples of native clay soils or clay fill encountered in the borings.

Reference is made to the boring logs in the Appendix which indicate approximate subsurface stratigraphy and soil descriptions, results of field and laboratory tests, as well as water level observations. Definitions of descriptive terminology are also included. While strata changes are shown as a definite line on the boring logs, the actual transition between soil layers will probably be more gradual. It should be noted that in the absence of foreign substances it is often very difficult or nearly impossible to distinguish samples of disturbed native soils from fill materials.

4.0 DISCUSSION OF TEST DATA

The following is a generalized description of the soil conditions found in our borings. The reader should refer to the individual Boring Logs in the Appendix for more specific details.

Pavement materials were found at the surface of Borings 1-4. The pavement materials consisted of approximately 3.5 to 4.2 inches in thickness of bituminous concrete (hot-mix asphalt) overlying crushed stone base material. The crushed stone base material thicknesses varied from approximately 10.5 to 14 inches at B-1 thru B-4. These pavement thicknesses should be considered approximate as they were estimated from the disturbed sides of the augered holes. Pavement cores should be taken if more exact measurements are required.

Manmade fill material was encountered below the surficial pavement materials in Borings 1-4, extending to depths varying from 6.0 to 9.0 feet below existing grade. Most of the fill encountered in these borings was composed of layers of sandy or silty clays with variable amounts of sand, crushed stone and/or gravel. Layers or seams of silty sand fill were found at varying depths in Borings 2 and 3. No documentation of the placement methods or compaction results of the fill at this site were available or provided to us. The strengths and relative densities of the fill appears to be variable. The unconfined compressive strengths of the clay fill varied widely from 0.5 to 3.25 tons per square foot (tsf) at moisture contents of between 9 and 21 percent. The Standard Penetration Test "N" values of the fill found in Borings 1-4 varied from 2 to 9 blows per foot (bpf). Based on the variability of the composition of the existing fill and the rather wide range of moisture contents, strength and "N" values of the fill found in the borings, it does not appear that the fill was placed in a tightly controlled manner.



Surficial topsoil was found in Boring 5, extending to a depth of 4.0 feet; some of this topsoil may be manmade fill material. A layer of topsoil material was found, below surficial layers of manmade fill, in each of Borings 1-4. The buried layers of topsoil varied in thickness (typically from 0.5 to 1.0 foot) and were generally found between depths of 6.0 feet and 10.0 feet below existing grade in these four borings. Moisture contents of the topsoil materials in the borings varied between 13 and 18 percent..

Layers of native, inorganic fine-grained and coarse-grained soils were found below the aforementioned materials and soils in the borings, extending to the boring termination depths. The native, inorganic fine-grained soils generally consisted of sandy, very silty or silty clays with variable amounts of sand and/or gravel, as well as sandy or clayey silts with occasional clay seams. The clays exhibited unconfined compressive strengths of 0.5 to 4.5+ tsf, characterizing them as soft to hard. Moisture contents of the sandy, very silty or silty clays varied between 11 and 33 percent. A layer of soft silty clay was found in the depth interval of 13.0 to 17.0 feet in B-2. The silts and sandy or clayey silts had Standard Penetration Test "N" values varying from 3 to 23 bpf, characterizing them as very loose to firm. A layer of very loose sandy silt was encountered in the depth interval of 6.5 to 8.0 feet in B-1.

The native granular soils encountered in the borings consisted of clayey or silty sands with variable amounts or less of gravel. These "loamy" sand deposits had Standard Penetration Test "N" values ranging from 1 to 14 bpf, characterizing them as very loose to firm. Layers of very loose "loamy" sands were found in the depth intervals of 11.0 to 13.0 feet and 17.0 to 26.0 feet below existing grade in B-2, 8.0 to 11.0 feet in B-3, 10.0 to 13.0 feet in B-4 and 4.0 to 7.0 feet in B-5.

All of the borings were "dry" while drilling. They remained dry upon completion of drilling and removal of the augers from the boreholes.

5.0 ANALYSIS AND RECOMMENDATIONS

5.1 Overview

Pavement materials were encountered at the surface of Borings 1-4, located in the area of the proposed building addition. Manmade fill and topsoil materials were found below the pavement materials in these



borings, extending to depths varying from 6.5 to 10.0 feet below existing grade. Underlying the surficial pavement, manmade fill and topsoil, generally, layers of native soft to hard sandy, very silty or silty clays and very loose to firm silty or clayey sands, silts or clayey silts was encountered in these borings, extending to the boring termination depths.

Surficial topsoil, extending to a depth of 4.0 feet below existing grade, was found overlying very loose clayey or silty sands and tough silty clay soil in Boring 5. Boring 5 was made on the west side of the existing school in the area of a proposed parking lot expansion.

The soil conditions encountered in the borings will create challenges to the design and construction of this project. The existing manmade fill, found in Borings 1-4 in the area of the proposed addition, does not appear to have been placed under strictly controlled conditions, as evidenced by its variability in composition and relative density. The existing uncontrolled fill and buried topsoil encountered in Borings 1-4 are not recommended for support of building foundations for this project. The fill and topsoil also generally provide a deficient surface for support of floor slabs. The underlying native soils were also often found to be soft or very loose; these poor native deposits extended to depths as great as 22 feet below existing grade. According to Mr. Scott R. Johnson, AIA, LEED AP of Richard L. Johnson Associates, Inc., the existing school building is supported on a drilled pier/ caisson foundation. However, design information with regards to the drilled pier/caisson foundation for the existing school building, such as depths of the caissons and design bearing capacity, could not be located and thus was not available to us at this time. Therefore, it is our opinion that one of the following options could be utilized for support of the proposed school addition structure:

1. Use of "intermediate depth" ground improvement methods, such as Rammed Aggregate Piers or Vibro Piers, to reinforce the existing manmade fill/native soils and provide support for foundation footings. If this option is chosen for foundation support, the existing fill could primarily remain in place. However, it is recommended that Rammed Aggregate Piers or Vibro Piers also be considered for use under the floor slab areas to tighten up the existing fill and reduce the potential for excessive floor slab settlement and distress.
2. A straight-shaft drilled pier or caisson foundation may alternately be considered for the addition. As previously noted, the existing school structure is supported on a drilled



pier/caisson foundation. It is recommended that the caissons extend through the existing fill and buried topsoil and below the very loose to loose "loamy" sands and soft clays to bear on the firm clayey silt or hard silty or very silty clay soils found below depths of 22 to 26 feet below existing grade. Caissons bearing on competent native, inorganic soils at this site may be proportioned for a bearing value of 6000 psf. Augered, cast-in-place piles could also be considered for this project. However, deeper borings would be recommended in order to make specific pile recommendations.

More specific information regarding our recommendations for each foundation alternate/option noted above is presented below in the following sections of this report.

5.2 "Intermediate Depth" Foundation System - Rammed Aggregate Piers or Vibro Piers

An intermediate depth foundation system, such as Rammed Aggregate Piers by Geopier Foundation Company or Vibro Piers by Hayward Baker, may be considered as an alternative for the building foundation. If the existing fill and native soils are improved using a system of Rammed Aggregate Piers or Vibro Piers, it is our judgement that the proposed building addition may also be supported on a conventional footing foundation. A design bearing pressure for footing foundations supported on the soil-Rammed Aggregate Piers or Vibro Piers matrix should be determined by a licensed specialty geotechnical professional/contractor hired to explore this option; it may be expected to be in the range of 3000 to 4000 pounds per square foot (psf). Considering the soil conditions and the size of the addition, if the risk of excessive floor slab settlement and distress can not be tolerated, then the Rammed Aggregate Piers or Vibro Piers should also be considered to improve the soil characteristics of the existing fill and soils under floor slab areas as well.

Rammed Aggregate Piers or Vibro Piers are typically constructed by drilling or reaming 2 to 3 foot diameter holes to depths generally ranging from 7 to 30 feet, depending on soil conditions. Following this, a specified aggregate is placed in the hole in lifts and compacted with proprietary equipment. The compaction forces the aggregate material downward and outward, and densifies the aggregate and surrounding soil. Conventional footing foundations may then be supported on the soil-Rammed Aggregate Pier/Vibro Pier matrix. Rammed Aggregate Piers or Vibro Piers are designed, as well as constructed, by a licensed specialty geotechnical contractor.



For frost considerations, all exterior/perimeter foundations should be constructed at least 4 feet below outside finished grade. With regard to foundation settlements, we anticipate that a Rammed Aggregate Pier/Vibro Pier-footing foundation supported structure will not experience gross and differential settlements greater than 1 and 1/2 inch, respectively.

5.3 Caissons

A foundation consisting of drilled piers or caissons may be considered as an option for the proposed addition. In addition, if the risk of settlement of the floor slabs can not be tolerated, it is recommended that the floor be structurally supported by the caissons as well. Caissons can be proportioned to exert a maximum net allowable bearing pressure of 6000 pounds per square foot (psf) where they bear within the firm clayey silt or hard silty or very silty clay soils found at and below depths of 22 to 26 feet below existing grade in the borings. It is recommended that the caissons extend sufficiently into these soil layers, at least a minimum of 1 to 2 feet, to verify that competent soil is present for bearing. It is estimated that caissons at Borings 1-4 will need to extend to depths of at least approximately 23 to 28 feet below existing grade or approximate Elevations 68 to 76. TSC personnel should be present on site during caisson installation to verify that competent bearing soil is being reached, as well as observe drilling operations and document pier dimensions.

Due to the presence of loose fill and sands, it will likely be necessary to case the holes to accomplish caisson installation. The contractor will need to plan and execute his field construction procedures to account for the soil conditions present at this site. An adequate "head" of concrete must be provided before pulling any temporary casings. It is anticipated that "belling" of caissons will not be practical due to the presence of silt bearing materials in several borings. Therefore, it is likely that straight-shaft caissons will need to be installed.

With regard to foundation settlements, we anticipate that a caisson supported structure will not experience gross and differential settlements greater than 1 and 1/2 inch, respectively.



5.4 Mass-Grading/Floor Slabs on Grade

It is recommended that building and new pavement areas be cleared of vegetation prior to mass-grading. It is recommended that stripping operations also include the removal of topsoil and any other deleterious materials, such as surficial manmade fill composed of topsoil or organic clays.

The existing fill deposits provide a deficient surface for support of floor slabs-on-grade. If no increased risk of settlement or distress can be tolerated, then the floors should be supported upon geopier-improved ground or caissons.

A Westergard's modulus of subgrade reaction (k) of 100 pci is recommended if it is decided to leave the existing fill material in place under floor slabs. It is anticipated that a k value in the range of 150 to 200 pci would be achievable if the fill soils are tightened up by use of geopiers/vibro-piers.

Prior to placement of any new fill or base course/subbase materials, the building and any pavement areas should be proof-rolled in order to detect the presence of unsuitable or highly unstable soil types. The proof-roll should be performed using a loaded dump truck or other approved piece of heavy construction equipment. All soft or unsuitable materials determined by proof-rolling should be removed and replaced, or otherwise remediated using an appropriate method.

Marginal subgrade stability at this site should be anticipated and planned for. Utilizing a minimum of 1 to 2 feet of coarse, crushed aggregate as the initial fill material can be anticipated to be necessary to provide a stable base for subsequent engineered fill placement. As previously mentioned in this report, utilizing granular fill below floor slabs and footing foundations is recommended for the addition.

The stability of the shallow clayey soils at this site is expected to be greatly dependent upon weather conditions prevailing prior to and during grading. Significantly less problems with subgrade stability may be anticipated if site grading work takes place during hotter/drier times of the year. In any event, the need for subgrade reworking or additional undercutting should be evaluated on the basis of proof-rolling. New fill should consist of approved granular materials or inorganic clays. It is recommended that compaction for building pad and any pavement areas be to a minimum of 95 and 90 percent of maximum dry density, respectively, as determined by the Modified Proctor test (ASTM D 1557). However, the



uppermost 2.0 feet of fill in any pavement areas should be compacted to 95 percent of Modified Proctor density. The fill should be placed in approximate 9 inch thick lifts loose measure for cohesive soils and up to 12 inches for granular materials, each lift to be compacted to the specified density prior to the placement of additional fill. It is recommended that select granular material be used as engineered fill or backfill in the building addition pad area.

Moisture control is important in the compaction of most soil types, and it is recommended that the water content of new fill be within 1 percentage point below and 3 percentage points above the optimum moisture as established by its laboratory compaction curve. If the soil is compacted too dry, it will have an apparent stability which will be lost if it later becomes saturated. If the soil is too wet, the Contractor will not be able to achieve proper compaction.

The traffic of heavy construction equipment frequently causes sandy clay and clayey or silty sand soils and deposits, such as were found in the borings, to experience a short term decrease in stability. The associated soft and spongy condition of exposed soils is commonly referred to as "pumping" in this area. It is recommended that heavy construction equipment be detoured around any areas where pumping conditions are found to be developing. Depending upon grading requirements and specific site conditions, solutions to a persistent pumping problem may include use of geotextile fabric, removal of unstable soils and replacement with about 1 to 2 feet of coarse, crushed granular backfill, such as 3-inch rock, construction of trench drains or a combination thereof.

5.5 Pavement Design and Construction

Pavement subgrade preparation may be in general accordance with previous recommendations for mass-grading. Boring 5 was performed in the area of the proposed parking lot expansion. Topsoil and very loose clayey or silty sands overlying tough silty clay was encountered in Boring 5. Where these soils or similar soils are encountered at or near pavement subgrade level, the uppermost 2 feet, approximately, of subgrade soils may need to be reworked and recompacted for those areas receiving new pavements. If paving construction is performed when drying of surficial soils cannot be accomplished, removal of any unstable subgrade and replacement with drier cohesive fill or one to two feet of coarse granular materials may be required.



It is our judgement that the topsoil and clayey or silty sand soils found shallowly below existing grade in the Boring 5, have a high to very high degree of frost susceptibility. These soils were found extending to a depth of 7.0 feet in Boring 5, including within the frost zone (less than 4 feet in depth). Frost susceptible soils should ideally not be placed or be allowed to remain within about 4 feet of final subgrade elevation. The designer should take the appropriate precautions regarding the pavement designs for frost susceptible soils. Please contact the undersigned if additional information is required.

It is recommended that a nominal Illinois Bearing Ratio (IBR) value of 2.0 be used in the design of pavements. A modulus of subgrade reaction (k) of 100 pci is recommended for concrete pavement design. Base course materials should conform to IDOT gradation CA-6 and be compacted to 95 percent Modified Proctor density or 100 percent of the Standard Proctor (ASTM D 698) maximum density value. Bituminous materials should conform to IDOT Hot-Mix Asphalt (HMA) requirements, Standard Specifications for Road and Bridge Construction. They should be compacted to between 93 and 97 percent of their theoretical maximum density, the G_{mm} or "Big D" as determined by IDOT.

5.6 Groundwater Management/Excavations

Although groundwater was not encountered in the borings made for this project to the depths drilled, the accumulation of run-off water or seepage at the base of excavations or over-excavations may still occur during foundation construction and mass-grading work. The Contractor should be prepared to remove these accumulations by dewatering procedures, as a minimum to include pumping from strategically placed sumps or other appropriate means based on the soil conditions encountered. Fluctuations in the groundwater levels should be anticipated. The magnitude of change will be depend on variations in precipitation, surface run-off or other environmental factors. Changes in nearby river or stream levels or below ground construction in the immediate vicinity may also result in variations in the groundwater level here.

Excavations at this site may be expected to encounter mostly surficial pavement materials, layers of varying thicknesses of fine- and coarse-grained manmade fill materials and/or near surface or buried topsoil overlying deeper deposits of "loamy" sands, clays and silts. All slope angles and protection systems for either open cut or supported excavations should be designed to meet or exceed all current applicable OSHA regulations. It should be noted that excavation safety is solely the responsibility of the contractor.

6.0 CLOSURE

It is recommended that full-time construction observation and testing services be provided by Testing Service Corporation personnel during foundation construction, so that the soils at undercut and foundation levels can be observed and tested. In addition, approval of building materials, stripping and undercutting, fill placement and compaction as well as slab-on-grade and pavement construction should be observed and tested for compliance with the recommended procedures and specifications.

Certain information regarding the proposed construction of the project has been furnished to Testing Service Corporation and is detailed in the introduction of this report. In the event that our understanding of the scope of the project is incomplete or incorrect, or if any changes in the design of the proposed development are planned, we should be informed of these facts so that we might have the opportunity to revise or modify our recommendations and conclusions, as appropriate.

The analysis and recommendations submitted in this report are based upon the data obtained from the five (5) soil borings performed by TSC at the locations indicated on the Boring Location Plan. This report does not reflect any variations which may occur between these borings, the nature and extent of which may not become evident until during the course of construction. If variations are then identified, recommendations contained in this report should be re-evaluated after performing on-site observations. We are available to review this report with you at your convenience.

Prepared by:



Steven R. Koester, P.E.
Vice President



Jeffrey L. Martin
Registered Professional Engineer
Illinois No. 062-047621



IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASFE/The Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size, and configuration; the location of the structure on the site; other improvements, such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report:

- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size, elevation, or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership; or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consultant to learn if additional tests are advisable before construction starts. Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEOENVIRONMENTAL CONCERNS ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations

about the potential for hazardous materials existing at the site. The equipment, techniques; and personnel used to perform a geoenvironmental exploration differ substantially from those applied in geotechnical engineering. Contamination can create major risks. If you have no information about the potential for your site being contaminated, you are advised to speak with your geotechnical consultant for information relating to geoenvironmental issues.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid misinterpretations, retain your geotechnical engineer to work with other project design professionals who are affected by the geotechnical report. Have your geotechnical engineer explain report implications to design professionals affected by them, and then review those design professionals' plans and specifications to see how they have incorporated geotechnical factors. Although certain other design professionals may be familiar with geotechnical concerns, none knows as much about them as a competent geotechnical engineer.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE REPORT

Geotechnical engineers develop final boring logs based upon their interpretation of the field logs (assembled by site personnel) and laboratory evaluation of field samples. Geotechnical engineers customarily include only final boring logs in their reports. Final boring logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes, and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, give contractors ready access to the complete geotechnical engineering report prepared or authorized for their use. (If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared and that developing construction cost esti-

mates was not one of the specific purposes for which it was prepared. In other words, while a contractor may gain important knowledge from a report prepared for another party, the contractor would be well-advised to discuss the report with your geotechnical engineer and to perform the additional or alternative work that the contractor believes may be needed to obtain the data specifically appropriate for construction cost estimating purposes.) Some clients believe that it is unwise or unnecessary to give contractors access to their geotechnical engineering reports because they hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems. It also helps reduce the adversarial attitudes that can aggravate problems to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical engineers. To help prevent this problem, geotechnical engineers have developed a number of clauses for use in their contracts, reports, and other documents. Responsibility clauses are not exculpatory clauses designed to transfer geotechnical engineers' liabilities to other parties. Instead, they are definitive clauses that identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report. Read them closely. Your geotechnical engineer will be pleased to give full and frank answers to any questions.

RELY ON THE GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE

Most ASFE-member consulting geotechnical engineering firms are familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a construction project, from design through construction. Speak with your geotechnical engineer not only about geotechnical issues, but others as well, to learn about approaches that may be of genuine benefit. You may also wish to obtain certain ASFE publications. Contact a member of ASFE or ASFE for a complimentary directory of ASFE publications.

ASFE PROFESSIONAL
FIRMS PRACTICING
IN THE GEOSCIENCES
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TESTING SERVICE CORPORATION

GENERAL CONDITIONS

Geotechnical and Construction Services

1. PARTIES AND SCOPE OF WORK: If Client is ordering the services on behalf of another, Client represents and warrants that Client is the duly authorized agent of said party for the purpose of ordering and directing said services, and in such case the term "Client" shall also include the principal for whom the services are being performed. Prices quoted and charged by TSC for its services are predicated on the conditions and the allocations of risks and obligations expressed in these General Conditions. Unless otherwise stated in writing, Client assumes sole responsibility for determining whether the quantity and the nature of the services ordered by Client are adequate and sufficient for Client's intended purpose. Unless otherwise expressly assumed in writing, TSC's services are provided exclusively for client. TSC shall have no duty or obligation other than those duties and obligations expressly set forth in this Agreement. TSC shall have no duty to any third party. Client shall communicate these General Conditions to each and every party to whom the Client transmits any report prepared by TSC. Ordering services from TSC shall constitute acceptance of TSC's proposal and these General Conditions.

2. SCHEDULING OF SERVICES: The services set forth in this Agreement will be accomplished in a timely and workmanlike manner. If TSC is required to delay any part of its services to accommodate the requests or requirements of Client, regulatory agencies, or third parties, or due to any cause beyond its reasonable control, Client agrees to pay such additional charges, if any, as may be applicable.

3. ACCESS TO SITE: TSC shall take reasonable measures and precautions to minimize damage to the site and any improvements located thereon as a result of its services or the use of its equipment; however, TSC has not included in its fee the cost of restoration of damage which may occur. If Client desires or requires TSC to restore the site to its former condition, TSC will, upon written request, perform such additional work as is necessary to do so and Client agrees to pay to TSC the cost thereof plus TSC's normal markup for overhead and profit.

4. CLIENT'S DUTY TO NOTIFY ENGINEER: Client represents and warrants that Client has advised TSC of any known or suspected hazardous materials, utility lines and underground structures at any site at which TSC is to perform services under this Agreement. Unless otherwise agreed in writing, TSC's responsibility with respect to underground utility locations is to contact the Illinois Joint Utility Locating Information for Excavators for the location of public, but not private, utilities.

5. DISCOVERY OF POLLUTANTS: TSC's services shall not include investigation for hazardous materials as defined by the Resource Conservation Recovery Act, 42 U.S.C. § 6901, et seq., as amended ("RCRA") or by any state or Federal statute or regulation. In the event that hazardous materials are discovered and identified by TSC, TSC's sole duty shall be to notify Client.

6. MONITORING: If this Agreement includes testing construction materials or observing any aspect of construction of improvements, Client's construction personnel will verify that the pad is properly located and sized to meet Client's projected building loads. Client shall cause all tests and inspections of the site, materials and work to be timely and properly performed in accordance with the plans, specifications, contract documents, and TSC's recommendations. No claims for loss, damage or injury shall be brought against TSC unless all tests and inspections have been so performed and unless TSC's recommendations have been followed.

TSC's services shall not include determining or implementing the means, methods, techniques or procedures of work done by the contractor(s) being monitored or whose work is being tested. TSC's services shall not include the authority to accept or reject work or to in any manner supervise the work of any contractor. TSC's services or failure to

perform same shall not in any way operate or excuse any contractor from the performance of its work in accordance with its contract. "Contractor" as used herein shall include subcontractors, suppliers, architects, engineers and construction managers.

Information obtained from borings, observations and analyses of sample materials shall be reported in formats considered appropriate by TSC unless directed otherwise by Client. Such information is considered evidence, but any inference or conclusion based thereon is, necessarily, an opinion also based on engineering judgment and shall not be construed as a representation of fact. Subsurface conditions may not be uniform throughout an entire site and ground water levels may fluctuate due to climatic and other variations. Construction materials may vary from the samples taken. Unless otherwise agreed in writing, the procedures employed by TSC are not designed to detect intentional concealment or misrepresentation of facts by others.

7. DOCUMENTS AND SAMPLES: Client is granted an exclusive license to use findings and reports prepared and issued by TSC and any sub-consultants pursuant to this Agreement for the purpose set forth in TSC's proposal provided that TSC has received payment in full for its services. TSC and, if applicable, its sub-consultant, retain all copyright and ownership interests in the reports, boring logs, maps, field data, field notes, laboratory test data and similar documents, and the ownership and freedom to use all data generated by it for any purpose. Unless otherwise agreed in writing, test specimens or samples will be disposed immediately upon completion of the test. All drilling samples or specimens will be disposed sixty (60) days after submission of TSC's report.

8. TERMINATION: TSC's obligation to provide services may be terminated by either party upon (7) seven days prior written notice. In the event of termination of TSC's services, TSC shall be compensated by Client for all services performed up to and including the termination date, including reimbursable expenses. The terms and conditions of these General Conditions shall survive the termination of TSC's obligation to provide services.

9. PAYMENT: Client shall be invoiced periodically for services performed. Client agrees to pay each invoice within thirty (30) days of its receipt. Client further agrees to pay interest on all amounts invoiced and not paid or objected to in writing for valid cause within sixty (60) days at the rate of twelve (12%) per annum (or the maximum interest rate permitted by applicable law, whichever is the lesser) until paid and TSC's costs of collection of such accounts, including court costs and reasonable attorney's fees.

10. WARRANTY: TSC's professional services will be performed, its findings obtained and its reports prepared in accordance with these General Conditions and with generally accepted principles and practices. In performing its professional services, TSC will use that degree of care and skill ordinarily exercised under similar circumstances by members of its profession. In performing physical work in pursuit of its professional services, TSC will use that degree of care and skill ordinarily used under similar circumstances. This warranty is in lieu of all other warranties or representations, either express or implied. Statements made in TSC reports are opinions based upon engineering judgment and are not to be construed as representations of fact.

Should TSC or any of its employees be found to have been negligent in performing professional services or to have made and breached any express or implied warranty, representation or contract, Client, all parties claiming through Client and all parties claiming to have in any way relied upon TSC's services or work agree that the maximum aggregate amount of damages for which TSC, its officers, employees and agents shall be liable is limited to \$50,000 or the total amount of the fee paid to TSC for its services performed with respect to the project, whichever amount is greater.

In the event Client is unwilling or unable to limit the damages for which TSC may be liable in accordance with the provisions set forth in the preceding paragraph, upon written request of Client received within five days of Client's acceptance of TSC's proposal together with payment of an additional fee in the amount of 5% of TSC's estimated cost for its services (to be adjusted to 5% of the amount actually billed by TSC for its services on the project at time of completion), the limit on damages shall be increased to \$500,000 or the amount of TSC's fee, whichever is the greater. This charge is not to be construed as being a charge for insurance of any type, but is increased consideration for the exposure to an award of greater damages.

11. INDEMNITY: Subject to the provisions set forth herein, TSC and Client hereby agree to indemnify and hold harmless each other and their respective shareholders, directors, officers, partners, employees, agents, subsidiaries and division (and each of their heirs, successors, and assigns) from any and all claims, demands, liabilities, suits, causes of action, judgments, costs and expenses, including reasonable attorneys' fees, arising, or allegedly arising, from personal injury, including death, property damage, including loss of use thereof, due in any manner to the negligence of either of them or their agents or employees or independent contractors. In the event both TSC and Client are found to be negligent or at fault, then any liability shall be apportioned between them pursuant to their pro rata share of negligence or fault. TSC and Client further agree that their liability to any third party shall, to the extent permitted by law, be several and not joint. The liability of TSC under this provision shall not exceed the policy limits of insurance carried by TSC. Neither TSC nor Client shall be bound under this indemnity agreement to liability determined in a proceeding in which it did not participate represented by its own independent counsel. The indemnities provided hereunder shall not terminate upon the termination or expiration of this Agreement, but may be modified to the extent of any waiver of subrogation agreed to by TSC and paid for by Client.

12. SUBPOENAS: TSC's employees shall not be retained as expert witnesses except by separate, written agreement. Client agrees to pay TSC pursuant to TSC's then current fee schedule for any TSC employee(s) subpoenaed by any party as an occurrence witness as a result of TSC's services.

13. OTHER AGREEMENTS: TSC shall not be bound by any provision or agreement (i) requiring or providing for arbitration of disputes or controversies arising out of this Agreement or its performance, (ii) wherein TSC waives any rights to a mechanics lien or surety bond claim; (iii) that conditions TSC's right to receive payment for its services upon payment to Client by any third party or (iv) that requires TSC to indemnify any party beyond its own negligence. These General Conditions are notice, where required, that TSC shall file a lien whenever necessary to collect past due amounts. This Agreement contains the entire understanding between the parties. Unless expressly accepted by TSC in writing prior to delivery of TSC's services, Client shall not add any conditions or impose conditions which are in conflict with those contained herein, and no such additional or conflicting terms shall be binding upon TSC. The unenforceability or invalidity of any provision or provisions shall not render any other provision or provisions unenforceable or invalid. This Agreement shall be construed and enforced in accordance with the laws of the State of Illinois. In the event of a dispute arising out of or relating to the performance of this Agreement, the breach thereof or TSC's services, the parties agree to try in good faith to settle the dispute by mediation under the Construction Industry Mediation Rules of the American Arbitration Association as a condition precedent to filing any demand for arbitration, or any petition or complaint with any court. Paragraph headings are for convenience only and shall not be construed as limiting the meaning of the provisions contained in these General Conditions.

APPENDIX

UNIFIED CLASSIFICATION CHART

LEGEND FOR BORING LOGS

BORING LOGS

BORING LOCATION PLAN

**TESTING SERVICE CORPORATION
UNIFIED CLASSIFICATION CHART**

CRITERIA FOR ASSIGNING GROUP SYMBOLS AND GROUP NAMES USING LABORATORY TESTS ^a					SOIL CLASSIFICATION	
					GROUP SYMBOL	GROUP NAME ^b
COARSE-GRAINED SOILS more than 50 % retained on No.200 sieve	GRAVELS More than 50 % of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5 % fines ^c	$C_u \geq 4$ and $1 \leq C_c \leq 3$ ^e	GW	Well graded gravel ^f	
			$C_u < 4$ and/or $1 > C_c > 3$ ^e	GP	Poorly graded gravel ^f	
		GRAVELS WITH FINES More than 12-% fines ^c	Fines classify as ML or MH	GM	Silty gravel f,g,h	
			Fines classify as CL or CH	GC	Clayey gravel f,g,h	
	SANDS 50 % or more of coarse fraction passes No. 4 sieve	CLEAN SANDS Less than 5 % fines ^d	$C_u \geq 6$ and $1 \leq C_c \leq 3$ ^e	SW	Well-graded sand ⁱ	
			$C_u < 6$ and/or $1 > C_c > 3$ ^e	SP	Poorly graded sand ⁱ	
		SANDS WITH FINES More than 12 % fines ^d	Fines classify as ML or MH	SM	Silty sand g,h,f	
			Fines classify as CL or CH	SC	Clayey sand g,h,f	
FINE-GRAINED SOILS 50 % or more passed the No.200 sieve	SILTS & CLAYS Liquid limit less than 50 %	Inorganic	PI ≥ 7 and plots on or above "A" line j	CL	Lean clay ^{k,l,m}	
			PI < 4 or plots below "A" line j	ML	Silt ^{k,l,m}	
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} \geq 0.75$	OL	Organic clay ^{k,l,m,n} Organic silt ^{k,l,m,o}	
	SILTS & CLAYS Liquid limit 50 % or more	Inorganic	PI plots on or above "A" line	CH	Fat clay ^{k,l,m}	
			PI plots below "A" line	MH	Elastic silt ^{k,l,m}	
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay ^{k,l,m,p} Organic silt ^{k,l,m,q}	
		Highly organic soils		Primarily organic matter, dark in color, and organic odor		PT

a. Based on the material passing the 3-in (75-mm) sieve.
b. If field sample contained cobbles and/or boulders, add "with cobbles and/or boulders" to group name.

c. Gravels with 5 to 12% fines require dual symbols

GW-GM well graded gravel with silt
GW-GC well graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

d. Sands with 5% to 12% fines require dual symbols

SW-SM well graded sand with silt
SW-SC well graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

e.

$$C_u = D_{60}/D_{10} \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

f. If soil contains $\geq 15\%$ sand, add "with sand" to group name.

g. If fines classify as CL-MH, use dual symbol GC-GM, SC-SM.

h. If fines are organic, add "with organic fines" to group name.

i. If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

j. If Atterberg Limits plot in hatched area, soil is a CL-MH, silty clay.

k. If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.

l. If soil contains $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.

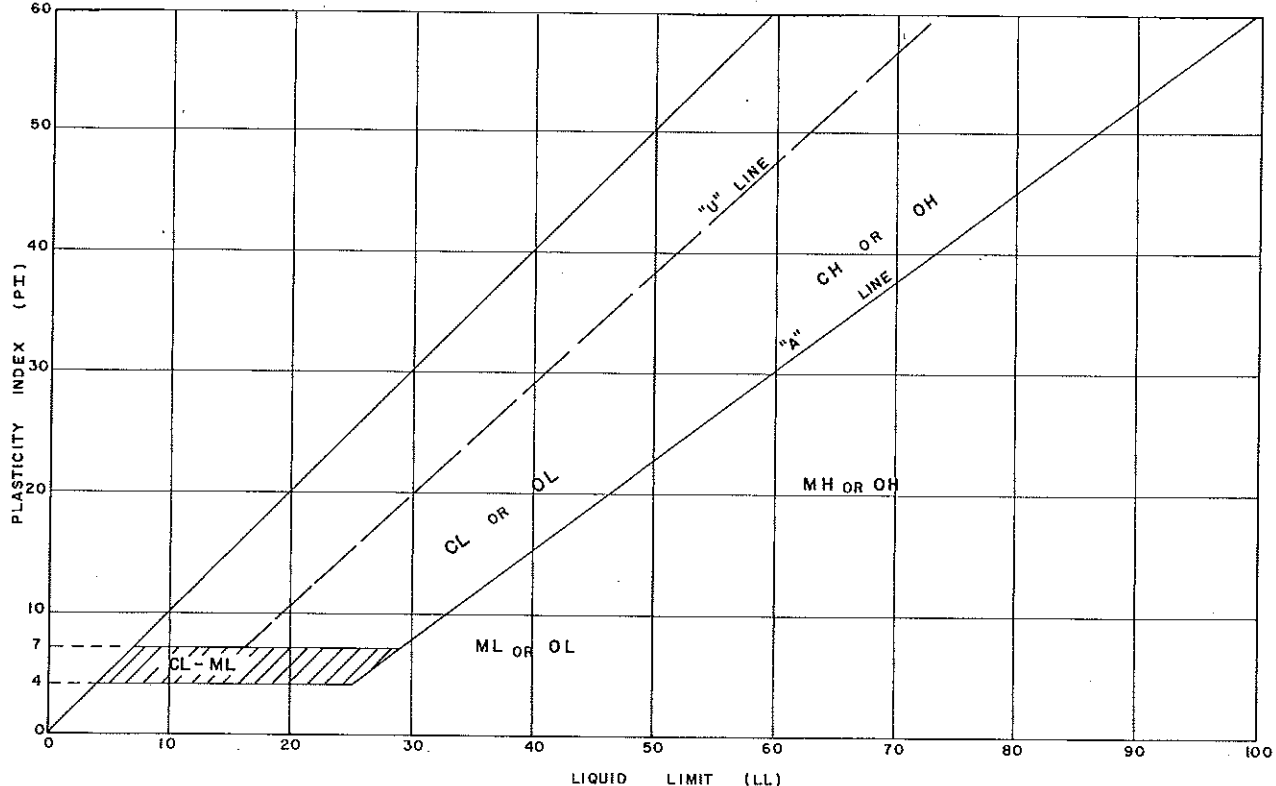
m. If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

n. PI ≥ 4 and plots on or above "A" line.

o. PI ≥ 4 or plots below "A" line.

p. PI plots on or above "A" line.

q. PI plots below "A" line.





TESTING SERVICE CORPORATION

LEGEND FOR BORING LOGS



FILL



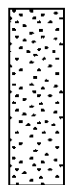
TOPSOIL



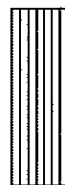
PEAT



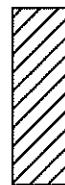
GRAVEL



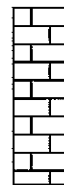
SAND



SILT



CLAY



DOLOMITE

SAMPLE TYPE

SS = Split Spoon
ST = Thin-Walled Tube
A = Auger
MC = Macro-Core (Geo Probe)

WATER LEVELS

▼ While Drilling
▽ End of Boring
▼ 24 Hours

FIELD AND LABORATORY TEST DATA

N = Standard Penetration Resistance in Blows per Foot
WC = In-Situ Water Content
Qu = Unconfined Compressive Strength in Tons per Square Foot
* Pocket Penetrometer Measurement: Maximum Reading = 4.5 tsf
Y_{DRY} = Dry Unit Weight in Pounds per Cubic Foot

SOIL DESCRIPTION

MATERIAL

BOULDER
COBBLE
Coarse GRAVEL
Small GRAVEL
Coarse SAND
Medium SAND
Fine SAND
SILT and CLAY

PARTICLE SIZE RANGE

Over 12 inches
12 inches to 3 inches
3 inches to $\frac{3}{4}$ inch
 $\frac{3}{4}$ inch to No. 4 Sieve
No. 4 Sieve to No. 10 Sieve
No. 10 Sieve to No. 40 Sieve
No. 40 Sieve to No. 200 Sieve
Passing No. 200 Sieve

COHESIVE SOILS

<u>CONSISTENCY</u>	<u>Qu (tsf)</u>
Very Soft	Less than 0.3
Soft	0.3 to 0.6
Stiff	0.6 to 1.0
Tough	1.0 to 2.0
Very Tough	2.0 to 4.0
Hard	4.0 and over

COHESIONLESS SOILS

<u>RELATIVE DENSITY</u>	<u>N (bpf)</u>
Very Loose	0 - 4
Loose	4 - 10
Firm	10 - 30
Dense	30 - 50
Very Dense	50 and over

MODIFYING TERM

Trace
Little
Some

PERCENT BY WEIGHT

1 - 10
10 - 20
20 - 35

PROJECT Lewis Lemon Elementary School Cafeteria Addition, Rockford, IllinoisCLIENT Richard L. Johnson Associates, Inc., Rockford, IllinoisBORING 1 DATE STARTED 7-15-15 DATE COMPLETED 7-15-15 JOB L-83,579

ELEVATIONS

GROUND SURFACE 97.2END OF BORING 67.2

WATER LEVEL OBSERVATIONS

▼ WHILE DRILLING Dry▼ AT END OF BORING Dry

▼ 24 HOURS

DISTANCE BELOW SURFACE IN FEET	LENGTH RECOVERY	SAMPLE		N	WC	Qu	γ _{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		NO.	TYPE							
0								0.3	96.9	3.5" Bituminous Concrete Surface Course(s)
								1.2	96.0	10.5" Crushed Stone
		1	SS	8	19.2	3.25*	110			FILL - Brown and light brown silty CLAY, moist (CL)
		2	SS	2	16.2	1.25*		3.0	94.2	
5										FILL - Brown and dark brown silty CLAY, little sand, trace gravel, very moist (CL)
		A	SS	3	13.8			6.0	91.2	Dark brown sandy, clayey TOPSOIL, very moist (OL)
		3			11.4			6.5	90.7	Very loose brown fine sandy SILT, moist (ML)
		B						8.0	89.2	
		4	SS	2	16.1	0.97 0.75*				Stiff brown silty CLAY, little to some sand, very moist (C)
10										
		5	SS	5	24.9	1.78 2.0*	100	11.0	86.2	Tough to very tough brown silty CLAY, moist (CL)
		A	SS	12	14.7	1.0*	118	13.0	84.2	Stiff brown sandy CLAY, trace gravel, very moist (CL)
		6			6.4			14.0	83.2	
		B								Firm light brown silty SAND, little to some gravel, trace clay, moist (SM)
15										
		7	SS	14	7.5					
20										
								22.0	75.2	
		8	SS	17	13.4	4.5+*	118			Hard light brown silty CLAY to very silty CLAY, some sand, little to some gravel, moist (CL-ML)
25										
								28.0	69.2	Firm tan to light brown clayey SILT with thin very tough CLAY seams, moist (ML/CH)
30		9	SS	23	15.4	3.30 3.75*				
35										

* Approximate unconfined compressive strength based on measurements with a calibrated pocket penetrometer.

End of Boring at 30.0'

DRILL RIG NO. 334

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

TSC_EOB 83579.GPJ TSC_ALL.GDT 11/13/15

PROJECT **Lewis Lemon Elementary School Cafeteria Addition, Rockford, Illinois**CLIENT **Richard L. Johnson Associates, Inc., Rockford, Illinois**BORING **2** DATE STARTED **7-15-15** DATE COMPLETED **7-15-15** JOB **L-83,579**

ELEVATIONS

GROUND SURFACE **97.3**END OF BORING **67.3**

WATER LEVEL OBSERVATIONS

▼ WHILE DRILLING **Dry**▼ AT END OF BORING **Dry**

▼ 24 HOURS

DISTANCE BELOW SURFACE IN FEET	LENGTH RECOVERY	SAMPLE		N	WC	Qu	γ _{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		NO.	TYPE							
0								0.3	97.0	4" Bituminous Concrete Surface Course(s)
								1.3	96.0	12" Crushed Stone Base
		A 1	SS	8	7.9					FILL - Light brown and brown silty fine SAND, moist (SM)
		B			9.1			3.0	94.3	
5		2	SS	2	20.5	1.0*	102			FILL - Brown, light brown and grayish-brown silty CLAY, trace to little fine sand, trace gravel, very moist (CL)
		3	SS	2	14.7	0.75*		8.0	89.3	
		A 4	SS	2	17.7	1.0*	104	9.0	88.3	Dark brown sandy, clayey TOPSOIL, very moist (OL)
10		B			16.9					Stiff brown sandy CLAY, very moist (CL-ML)
		5	SS	3	10.9			11.0	86.3	
		6	SS	2	32.8	0.58		13.0	84.3	Very loose light brown to orangish-brown clayey SAND, very moist (SC)
15					0.5*					Soft light brown to rusty brown silty CLAY, very moist (CL)
		7	SS	1	12.0	0.75*		17.0	80.3	
20										Very loose to loose light brown clayey SAND and silty SAND, little gravel, very moist to moist (SC/SM)
		8	SS	7	8.3					
25								26.0	71.3	Firm tan to light brown clayey SILT with very tough CLAY seams, moist (ML/CH)
30		9	SS	16	15.9	3.09				
					3.5*					
35										

* Approximate unconfined compressive strength based on measurements with a calibrated pocket penetrometer.

Driller's Comment: "Pounded on a rock at depth of 23.5 feet."

End of Boring at 30.0'

Division lines between deposits represent approximate boundaries between soil types; In-situ, the transition may be gradual.

DRILL RIG NO. **334**

TSC_EOB 83579.GPJ TSC_ALL.GDT 11/12/15

PROJECT Lewis Lemon Elementary School Cafeteria Addition, Rockford, IllinoisCLIENT Richard L. Johnson Associates, Inc., Rockford, IllinoisBORING 3 DATE STARTED 7-15-15 DATE COMPLETED 7-15-15 JOB L-83,579

ELEVATIONS

GROUND SURFACE 98.6END OF BORING 68.6

WATER LEVEL OBSERVATIONS

▽ WHILE DRILLING Dry▽ AT END OF BORING Dry

▽ 24 HOURS

DISTANCE BELOW SURFACE IN FEET	LENGTH RECOVERY	SAMPLE		N	WC	Qu	Y _{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		NO.	TYPE							
0								0.4	98.2	4.2" Bituminous Concrete Surface Course(s)
								1.3	97.3	11.8" Crushed Stone Base
		A 1	SS	8	6.6 12.0	1.75*				FILL - Dark brown and pinkish-brown sandy CLAY, trace gravel, crushed stone and roots, moist (CL-ML)
		B								
		2	SS	2	13.1	1.0*	134			FILL - Dark brown, brown and light brown silty CLAY, some sand, trace gravel and crushed stone, with silty fine sand seams, moist (CL/SM)
5		A 3	SS	3	16.2 16.0	1.0* 2.0*	110	5.5	93.1	
		B						7.0	91.6	Dark brown sandy, clayey TOPSOIL, moist (OL) Very loose dark brown to brown clayey fine SAND, very moist (SC)
		A 4	SS	2	13.1 9.9			8.0	90.6	
		B								Tough brown and rusty brown silty CLAY, very moist (CL)
10		5	SS	4	24.9	1.5*	98	11.0	87.6	
		6	SS	3	16.5	0.78 0.75*		13.0	85.6	Stiff brown silty CLAY, little to some sand, trace gravel, very moist (CL)
15										
		7	SS	11	9.1			17.0	81.6	Firm light brown silty SAND, little gravel, trace clay, moist (SM)
20										
		8	SS	23	20.5			22.0	76.6	Firm light brown clayey SILT, very moist (ML)
25										
		9	SS	22	13.9	3.25*		27.0	71.6	Firm tan and yellowish-brown clayey SILT with very tough CLAY seams, moist (ML/CH)
30										
35										* Approximate unconfined compressive strength based on measurements with a calibrated pocket penetrometer.

Division lines between deposits represent
approximate boundaries between soil types;
in-situ, the transition may be gradual.

End of Boring at 30.0'

DRILL RIG NO. 334

TSC_EOB 83579.GPJ TSC_ALL.GDT 11/12/15

PROJECT Lewis Lemon Elementary School Cafeteria Addition, Rockford, IllinoisCLIENT Richard L. Johnson Associates, Inc., Rockford, IllinoisBORING 4 DATE STARTED 7-15-15 DATE COMPLETED 7-15-15 JOB L-83,579

ELEVATIONS

GROUND SURFACE 99.4
END OF BORING 69.4

WATER LEVEL OBSERVATIONS

▽ WHILE DRILLING Dry
▽ AT END OF BORING Dry
▽ 24 HOURS

DISTANCE BELOW SURFACE IN FEET	LENGTH RECOVERY	SAMPLE		N	WC	Qu	γ _{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		NO.	TYPE							
0								0.3	99.1	4" Bituminous Concrete Surface Course(s)
								1.5	97.9	14" Crushed Stone Base
		A 1	SS	9	3.9 9.6	2.0*	126			FILL - Brown, gray and dark gray sandy CLAY, little gravel, moist (CL-ML)
		B						3.0	96.4	
		2	SS	5	13.8	1.25*	115			FILL - Pinkish-brown and brown silty CLAY, some sand, trace gravel, moist (CL)
5								5.5	93.9	
		3	SS	2	15.2	0.6*	112			FILL - Brown and dark brown sandy CLAY, very moist (CL)
		A 4	SS	2	12.4 16.4	1.0*	124 108	9.0	90.4	Dark brown sandy, clayey TOPSOIL, very moist (OL)
10		B						10.0	89.4	
		5	SS	2	9.7					Very loose brown clayey fine SAND, very moist (SC)
								13.0	86.4	
		6	SS	4	29.5	0.97 1.25*	94			Stiff to tough brown silty CLAY, very moist (CL)
15								17.0	82.4	
		7	SS	9	8.9					Loose light brown silty SAND, some gravel, trace clay, moist (SM)
20								22.0	77.4	
		8	SS	18	19.6	3.0*				Firm light brown clayey SILT, moist (ML)
25								27.0	72.4	
		9	SS	34	11.8	4.5+*				Hard light brown to orangish-brown very silty CLAY, some sand and gravel with dense silty sand seams, moist (CL-ML/SM)
30										
35										

* Approximate unconfined compressive strength based on measurements with a calibrated pocket penetrometer.

Division lines between deposits represent approximate boundaries between soil types; in-situ, the transition may be gradual.

End of Boring at 30.0'

DRILL RIG NO. 334

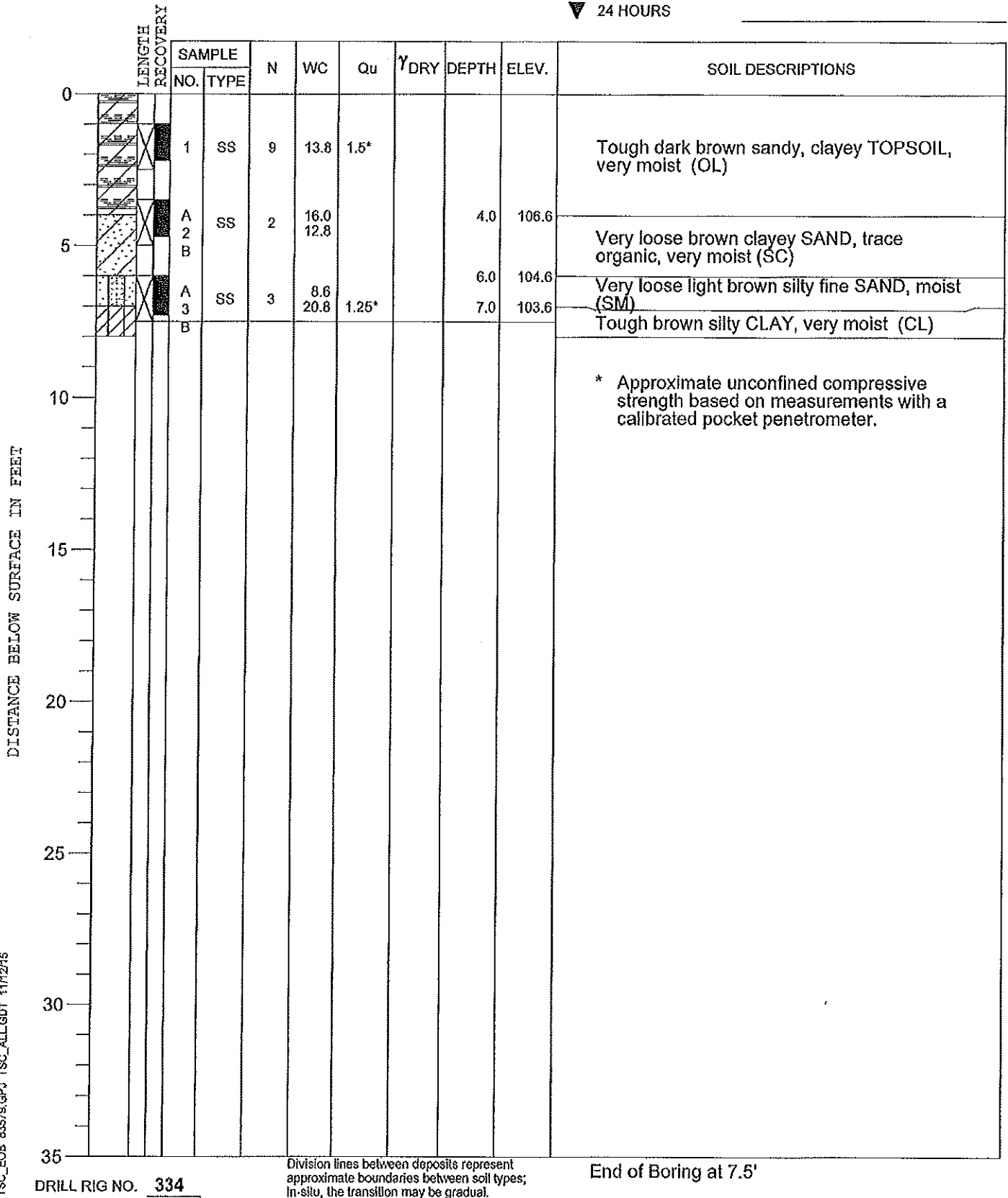
PROJECT Lewis Lemon Elementary School Cafeteria Addition, Rockford, IllinoisCLIENT Richard L. Johnson Associates, Inc., Rockford, IllinoisBORING 5 DATE STARTED 7-15-15 DATE COMPLETED 7-15-15 JOB L-83,579

ELEVATIONS

GROUND SURFACE 110.6
END OF BORING 103.1

WATER LEVEL OBSERVATIONS

▼ WHILE DRILLING Dry
 ▼ AT END OF BORING Dry
 ▼ 24 HOURS



**BORING LOCATION PLAN
PROPOSED CAFETERIA BUILDING ADDITION
LEWIS LEMON ELEMENTARY SCHOOL
1993 MULBERRY STREET
ROCKFORD, ILLINOIS
NOVEMBER, 2015
TSC JOB NO. L-83,579**

