

PROJECT MANUAL

Including Conditions of Contract and Specifications

PATRICK HENRY HIGH SCHOOL FIELDHOUSE

Roanoke City Public Schools

September 30, 2020

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Invitation to Bid issued by Roanoke City Public Schools.

1.2 PROJECT IDENTIFICATION: Patrick Henry High School Fieldhouse

LOCATION: 2102 Grandin Road
Roanoke, VA 24015

OWNER: School Board of the City of Roanoke, Virginia
40 Douglass Avenue, N.W.
Roanoke, VA 24012

- A. Contract Documents, dated September 30, 2020 were prepared for the Project by:

Interactive Design Group
301 6th Street, SW
Roanoke, VA 24016
Tel: 540/342-7534
Fax: 540/342-7536
Richard A. Rife, Project Manager
E-Mail: richard.rife@idgarchitecture.com

- B. The Owner's Representative is:
Jeffrey Shawver, Chief of Physical Plants
Tel: 540/853-6306
Email: jshawver@rcps.info
- C. The Work consists of the construction of a new 2-story building, as well as associated site improvements.
- D. The Work will be constructed under a lump-sum Contract that will be administered by the Owner. The Owner intends to award the Contract to the responsible bidder submitting the lowest lump-sum bid

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1.3 WORK UNDER OTHER CONTRACTS

- A. Separate Contract: The Owner will award separate contracts for performance of certain other construction operations at the site. Those operations are scheduled to begin before work under this Contract is completed, but will not fall within the work area of this contract.

1.4 CONTRACTOR USE OF PREMISES

- A. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
 - 1. Utilities: Do not interrupt utility service to the site or buildings without prior approval by Owner.

1.5 OWNER-FURNISHED PRODUCTS

- A. Pre-purchased and pre-ordered items: None.
- B. Owner purchased, Owner installed items:
 - 1. Security camera system (conduit by Contractor).
 - 2. Video Projectors and cameras (conduit, data and power by Contractor).
 - 3. Furnishings and movable equipment.
 - 4. Laundry equipment and ice machine.
 - 5. Sports equipment.
 - 6. Certain toilet accessories.
 - 7. Lock cylinder permanent cores.
- C. Owner-purchased, Contractor installed items: None

1.6 MISCELLANEOUS PROVISIONS

- A. Permits: Apply for, Obtain and pay for permits required to perform the work. Display permits in appropriate location. Contractors shall pay for the various utility connection fees (except AEP). The Owner shall pay the AEP connection fee directly.
- B. Codes: Comply with applicable codes and regulations of authorities having jurisdiction. Schedule and coordinate inspections by various Building Inspectors.
- C. Dimensions: Verify dimensions indicated on drawings with field dimensions before fabrication or ordering of materials. Do not scale drawings.
- D. Existing Conditions: Visit site prior to submission of bid to verify existing conditions.

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- E. Definitions for terms used in specifications:
1. Provide: Furnish and install, complete with all necessary accessories, ready for intended use. Pay for all related costs.
 2. Approved: Acceptance of item submitted for approval. Not a limitation or release for compliance with the Contract Documents or regulatory requirements. Refer to limitations of AApproved@ in General and Supplementary Conditions.
 3. Match Existing: Match existing as Acceptable to the Architect.
- F. Intent: Drawings and specifications are intended to provide the basis for proper completion of the work suitable for the intended use of the Owner. Anything not expressly set forth but which is reasonably implied or necessary for proper performance of the project shall be included.
- G. Writing Style: Specifications are written in the imperative mode. Except where specifically intended otherwise, the subject of all imperative statements is the Contractor. For example, "Provide tile" means "Contractor shall provide tile".

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION | |

END OF SECTION 01 11 00

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SECTION 01 26 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Submittals" for requirements for the Contractor's Construction Schedule.
 - 2. Division 1 Section "Applications for Payment" for administrative procedures governing Applications for Payment.
 - 3. Division 1 Section "Product Substitutions" for administrative procedures for handling requests for substitutions made after award of the Contract.

1.3 MINOR CHANGES IN THE WORK

- A. The Owner or Architect may issue the Architect's supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time, on AIA Form G710, Architect's Supplemental Instructions, or other appropriate forms.

1.4 CHANGE ORDER PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: The Architect will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal requests issued by the Architect are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.

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2. Within 7 days of receipt of a proposal request, submit an estimate of cost necessary to execute the change to the Architect for the Architect's and the Owner's review.
 - a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.
 - B. See Sections of the General Conditions for additional information regarding Change Orders.
 - C. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Architect.
 1. Include a statement outlining the 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 Contract Time.
 2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Comply with requirements in Section "Product Substitutions" if the proposed change requires substitution of one product or system for a product or system specified.
 - D. Proposal Request Form: Use AIA Document G709 for Change Order Proposal Requests.
 - E. Proposal Request Form: Use forms provided by the Owner for Change Order Proposals.
- 1.5 CONSTRUCTION CHANGE DIRECTIVE
- A. Construction Change Directive: When the Owner and the Contractor disagree on the terms of a Proposal Request, the Architect may issue an Architect's Construction Change Directive on AIA Form G714. The Construction Change Directive instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. The Construction Change Directive contains a complete description of the change in the Work. It also designates the method to be followed to determine change in

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the Contract Sum or Contract Time.

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

1. necessary to substantiate cost and time adjustments to the Contract.

1.6 CHANGE ORDER PROCEDURES

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

PART 2) - PRODUCTS (Not Applicable)

PART 3) - EXECUTION (Not Applicable)

END OF SECTION 01035

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SECTION 01 29 00 - APPLICATIONS FOR PAYMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements governing each prime contractor's Applications for Payment.
 - 1. Coordinate the Schedule of Values and Applications for Payment with the Contractor's Construction Schedule, Submittal Schedule, and List of Subcontracts.
- B. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Schedules: The Contractor's Construction Schedule and Submittal Schedule are specified in Division 1 Section "Submittals."

1.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
 - a. Contractor's Construction Schedule.
 - b. Application for Payment forms, including Continuation Sheets.
 - c. List of subcontractors.
 - d. Schedule of allowances.
 - e. Schedule of alternates.
 - f. List of principal suppliers and fabricators.
 - 2. Submit the Schedule of Values to the Construction Manager at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.

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- B. Format and Content: Use the Project Manual table of contents as a guide to establish the format 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 the Architect.
 - c. Project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Name of subcontractor.
 - c. Name of manufacturer or fabricator.
 - d. Name of supplier.
 - e. Dollar value: Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.
 4. Round amounts to nearest whole dollar; the 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. Contractor may receive payment for materials stored off-site only if materials are stored in an insured and bonded warehouse.
 6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
 7. Schedule Updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

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1.4 APPLICATIONS FOR PAYMENT |

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Architect and paid for by the Owner.
 - 1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements. |
- B. Payment-Application Times: As agreed by the Contractor and Owner. |
- C. Payment-Application Forms: Use AIA Document G702 and Continuation Sheets G703 as the form for Applications for Payment. |
- D. Application Preparation: Complete every entry on the form. Include notarization and execution by a person authorized to sign legal documents on behalf of the Contractor. The Architect will return incomplete applications without action.
 - 1. Entries shall match data on the Schedule of Values and the Contractor's Construction Schedule. Use updated schedules if revisions were made.
 - 2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application. |
- E. Transmittal: Submit four (4) signed and notarized original copies of each Application for Payment to the Construction Manager by a method ensuring receipt within 24 hours. One copy shall be complete, including waivers of lien and similar attachments, when required.
 - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the Construction Manager. |
- F. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following: |
 - 1. List of subcontractors.
 - 2. List of principal suppliers and fabricators.
 - 3. Schedule of Values.
 - 4. Contractor's Construction Schedule (preliminary if not final).
 - 5. Submittal Schedule (preliminary if not final).
 - 6. Copies of building permits.
 - 7. Initial progress report.
 - 8. Report of preconstruction meeting.
 - 9. Certificates of insurance and insurance policies. |
 - 10. Performance and payment bonds.
- G. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.

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1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
2. Administrative actions and submittals that shall precede or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Test/adjust/balance records.
 - d. Maintenance instructions.
 - e. Meter readings.
 - f. Startup performance reports.
 - g. Changeover information related to Owner's occupancy, use, operation, and maintenance.
 - h. Final cleaning.
 - i. Application for reduction of retainage and consent of surety.
 - j. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion.

H. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:

1. Completion of Project closeout requirements.
2. Completion of items specified for completion after Substantial Completion.
3. Ensure that unsettled claims will be settled.
4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
5. Transmittal of required Project construction records to the Owner.
6. Removal of temporary facilities and services.
7. Removal of surplus materials, rubbish, and similar elements.
8. Change of door locks to Owner's access.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 29 00

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SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Coordination Drawings.
 - 3. Administrative and supervisory personnel.
 - 4. Project meetings.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Closeout Procedures" for coordinating Contract closeout.

1.2 COORDINATION

- A. Coordination: Coordinate construction operations included in various 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 with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

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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.

1.3 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Indicate relationship of components shown on separate Shop Drawings.
 2. Indicate required installation sequences.
 3. Refer to Division 15 Section "Basic Mechanical Materials and Methods" and Division 16 Section "Basic Electrical Materials and Methods" for specific Coordination Drawing requirements for mechanical and electrical installations.
- B. Staff Names: Within 15 days of starting construction operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers.

1.4 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Field Superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.
- B. Communications Requirements:
1. All Contractors shall maintain an active e-mail account and address and a fax machine for the full duration of the project so they may send and receive correspondence and communications.
 2. All Field Superintendents for each Contractor shall maintain an active cell phone in the field for the full duration of the project so they may communicate with the Construction Manager's Superintendent.
 3. All Contractors shall provide 24-hour emergency phone number(s) and contact person(s).

1.5 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

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1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within 3 days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing.
 - d. Designation of responsible personnel.
 - e. Review Solid Waste Management and Environmental Protection Plan.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for processing Applications for Payment.
 - h. Distribution of the Contract Documents.
 - i. Submittal procedures.
 - j. Preparation of Record Documents.
 - k. Use of the premises.
 - l. Responsibility for temporary facilities and controls.
 - m. Parking availability.
 - n. Office, work, and storage areas.
 - o. Equipment deliveries and priorities.
 - p. First aid.
 - q. Security.
 - r. Progress cleaning.
 - s. Working hours.
- C. Preinstallation Conferences: The Contractor shall prepare and submit to the Architect a schedule of preinstallation conferences, which will include meetings to be held before significant construction activity requiring coordination with other construction. These include, but are not limited to, demolition of existing facilities, installation of below-

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grade utilities and construction; installation of exposed masonry including cast masonry units, brick and cast stone; roof installation.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related Change Orders.
 - d. Purchases.
 - e. Deliveries.
 - f. Submittals.
 - g. Review of mockups.
 - h. Possible conflicts.
 - i. Compatibility problems.
 - j. Time schedules.
 - k. Weather limitations.
 - l. Manufacturer's written recommendations.
 - m. Warranty requirements.
 - n. Compatibility of materials.
 - o. Acceptability of substrates.
 - p. Temporary facilities and controls.
 - q. Space and access limitations.
 - r. Regulations of authorities having jurisdiction.
 - s. Testing and inspecting requirements.
 - t. Required performance results.
 - u. Protection of construction and personnel.
 3. The Contractor shall record significant conference discussions, agreements, and disagreements, and distribute the minutes of the meetings to all attendees.
 4. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at regular intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

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2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Review Solid Waste Management and Environmental Protection Plan.
 - 14) Change Orders.
 - 15) Documentation of information for payment requests.
3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.
 - 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 01 31 00

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SECTION 01 26 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Submittals" for requirements for the Contractor's Construction Schedule.
 - 2. Division 1 Section "Applications for Payment" for administrative procedures governing Applications for Payment.
 - 3. Division 1 Section "Product Substitutions" for administrative procedures for handling requests for substitutions made after award of the Contract.

1.3 MINOR CHANGES IN THE WORK

- A. The Owner or Architect may issue the Architect's supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time, on AIA Form G710, Architect's Supplemental Instructions, or other appropriate forms.

1.4 CHANGE ORDER PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: The Architect will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal requests issued by the Architect are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.

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2. Within 7 days of receipt of a proposal request, submit an estimate of cost necessary to execute the change to the Architect for the Architect's and the Owner's review.
 - a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.
 - B. See Sections of the General Conditions for additional information regarding Change Orders.
 - C. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Architect.
 1. Include a statement outlining the 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 Contract Time.
 2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Comply with requirements in Section "Product Substitutions" if the proposed change requires substitution of one product or system for a product or system specified.
 - D. Proposal Request Form: Use AIA Document G709 for Change Order Proposal Requests.
 - E. Proposal Request Form: Use forms provided by the Owner for Change Order Proposals.
- 1.5 CONSTRUCTION CHANGE DIRECTIVE
- A. Construction Change Directive: When the Owner and the Contractor disagree on the terms of a Proposal Request, the Architect may issue an Architect's Construction Change Directive on AIA Form G714. The Construction Change Directive instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. The Construction Change Directive contains a complete description of the change in the Work. It also designates the method to be followed to determine change in

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the Contract Sum or Contract Time.

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

1. necessary to substantiate cost and time adjustments to the Contract.

1.6 CHANGE ORDER PROCEDURES

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

PART 2) - PRODUCTS (Not Applicable)

PART 3) - EXECUTION (Not Applicable)

END OF SECTION 01035

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SECTION 01 45 16 - FIELD ENGINEERING

PART 1) - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. General: This Section specifies administrative and procedural requirements for field-engineering services including, but not limited to, the following:
 - 1. Land survey work.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.

1.3 SUBMITTALS

- A. Project Record Documents: Submit a record of Work performed and record survey data as required under provisions of "Submittals" and "Project Closeout" Sections.

PART 2) - PRODUCTS (Not Applicable)

PART 3) - EXECUTION

3.1 EXAMINATION

- A. Verify layout information shown on the Drawings, in relation to the property survey and existing benchmarks, before proceeding to lay out the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.
 - (1) Do not change or relocate benchmarks or control points without prior written

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approval. Promptly report lost or destroyed reference points or requirements to relocate reference points because of necessary changes in grades or locations.

2. Promptly replace lost or destroyed Project control points. Base replacements on the original survey control points.

B. Existing Utilities and Equipment: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction.

1. Prior to construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping.

3.2 PERFORMANCE

A. Work from lines and levels established by the property survey. Establish benchmarks and markers to set lines and levels at each story of construction and elsewhere as needed to locate each element of the Project. Calculate and measure required dimensions within indicated or recognized tolerances. Do not scale Drawings to determine dimensions.

1. Advise entities engaged in construction activities of marked lines and levels provided for their use.
2. As construction proceeds, check every major element for line, level, and plumb.

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

C. Building Lines and Levels: Locate and lay out batter boards for structures, building foundations, column grids and locations, floor levels, and control lines and levels required for mechanical and electrical work. Verify elevations of existing floor slabs to be matched.

D. Existing Utilities: Furnish information necessary to adjust, move, or relocate existing structures, utility poles, lines, services, or other appurtenances located in or affected by construction. Coordinate with local authorities having jurisdiction.

END OF SECTION 01 45 16

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SECTION 01 50 00 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1) - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. See Division 2 Section “Fences and Gates” for requirements for security fencing around site.

1.2 SUMMARY

- A. This Section includes requirements for construction facilities and temporary controls, including temporary utilities, support facilities, and security and protection. Some of these facilities will be in place and provided by others.
- B. Temporary utilities include, but are not limited to, the following:
 - 1. Water service and distribution – by Plumbing Contractor
 - 2. Temporary electric power and light – by Electrical Contractor
 - 3. Temporary heat – by Mechanical Contractor
 - 4. Ventilation – by Mechanical Contractor
 - 5. Telephone service – by each contractor
 - 6. Sanitary facilities – by General Contractor
 - 7. Storm and sanitary sewer – by Site Contractor
 - 8. Drinking Water – by each contractor
- C. Support facilities include, as needed by each contractor but are not limited to, the following:
 - 1. Field offices and storage sheds.
 - 2. Temporary roads and paving.
 - 3. Dewatering facilities and drains.
 - 4. Temporary enclosures.
 - 5. Hoists and temporary elevator use.
 - 6. Temporary project identification signs and bulletin boards.
 - 7. Waste disposal services.
 - 8. Construction aids and miscellaneous services and facilities.
- D. Security and protection facilities include, but are not limited to, the following:
 - 1. Temporary fire protection.

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2. Barricades, warning signs, and lights.
3. Temporary fencing and signage around the construction area to exclude the public from accessing the construction area.
4. Environmental protection.

1.3 QUALITY ASSURANCE

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, the following:
 1. Building code requirements.
 2. Health and safety regulations.
 3. Utility company regulations.
 4. Police, fire department, and rescue squad rules.
 5. Environmental protection regulations.
- B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."
 1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.4 PROJECT CONDITIONS

- A. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.

PART 2) - PRODUCTS

2.1 EQUIPMENT

- A. General: Provide new equipment.
- B. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate

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lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

- C. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.
- D. Temporary Office: As needed and as site allows provide prefabricated or mobile unit with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.
- E. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures.
 - 1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3) - EXECUTION

3.1 INSTALLATION

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. 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. Locate field offices, storage sheds, and other temporary construction and support facilities at locations approved by the Owner and / or Architect.
 - 1. Maintain support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.
- B. Provide incombustible construction for offices, shops, and sheds located within the construction area or within 30 feet of building lines. Comply with requirements of NFPA 241.

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- C. Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at the Project Site. Keep the office clean and orderly.
- D. Storage and Fabrication Sheds: Install storage and fabrication sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service. Sheds may be open shelters or fully enclosed spaces within the building or elsewhere on-site as approved by the Owner.
- E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
 - 1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 - 2. Install tarpaulins securely, with wood framing and other materials. Close openings of 25 sq. ft. or less with plywood or similar materials.
 - 3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
- F. Temporary Lifts and Hoists: Provide facilities for hoisting materials and employees. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- G. Project Identification and Temporary Signs: Must be approved and coordinated with the Owner. Support on posts or framing of preservative-treated wood or steel. Unauthorized signs are not permitted.
 - 1. Project Identification Signs: Engage an experienced sign fabricator. Comply with the design provided by the architect.
 - 2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.
- L. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 deg F. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Temporary Fire Protection: Until fire-protection needs are supplied by permanent

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facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations."

1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell.
 2. Store combustible materials in containers in fire-safe locations.
 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire-exposure areas.
 4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
- B. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights. Provide barricades as required to separate student areas and paths from construction areas.
- C. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the site.

3.4 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities provided by all contractors and Owner. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
 2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

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- C. Termination and Removal: Unless the Owner requests that it be maintained longer, remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are the Contractor's property.
 2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where the area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at the temporary entrances, as required by the governing authority.
 3. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:
 - a. Replace air filters and clean inside of ductwork and housings.
 - b. Replace significantly worn parts and parts subject to unusual operating conditions.
 - c. Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 01 50 00

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SECTION 01600 – PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. Related Sections include the following:
 - 1. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

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

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- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
- E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.3 SUBMITTALS

- A. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
 - 1. Coordinate product list with Contractor's Submittals Schedule.
 - 2. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of an initial product list. Provide a written explanation for omissions of data and for known variations from Contract requirements.
 - a. At the Contractor's option, the initial submittal may be limited to product selections and designations that must be established early in the Contract period.
 - 3. Completed List: Within 60 days after award of bid, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
 - 4. Architect's Action: Architect will respond in writing to Contractor within 15 days of receipt of completed product list. Architect's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Architect's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.
- B. Substitution Requests: Substitutions are not permitted.
- C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 1 Section "Project Management." Show compliance with requirements.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
 - 1. Store products only in areas approved by General Contractor and Owner.
 - 2. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

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3. 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.
4. 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.
5. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
6. Store products to allow for inspection and measurement of quantity or counting of units.
7. Store materials in a manner that will not endanger site, personnel or persons on or around construction site.
8. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
9. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
10. Protect stored products from damage.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
 1. Standard Products: 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.
 2. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 3. Descriptive, performance, and referenced standard requirements in the Specifications establish "salient characteristics" of products.
- B. Product Selection Procedures: Procedures for product selection include the following:
 1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
 - a. Substitutions will not be considered.
 2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a

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product by the manufacturer or from the source named that complies with requirements.

- a. Substitutions will not be considered.
3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
 - a. Substitutions will not be considered.
 4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 - a. Substitutions will not be considered.
 5. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Product[s]" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.

2.2 PRODUCT SUBSTITUTIONS

- A. See Section 016200- Substitutions for product substitution procedures.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 016200 - SUBSTITUTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for handling requests for substitutions made during the Bidding process and after the award of the Contract.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Project Management" specifies requirements for submitting the Contractor's Construction Schedule and the Submittal Schedule.
 - 2. Division 1 Section "Product Requirements" specifies requirements governing the Contractor's selection of products and product options.

1.3 DEFINITIONS

- A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Requests for alternative products to be considered "Equal" to those specified prior to receipt of bids. Changes in products, materials, equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions. The following are not considered to be requests for substitutions:
 - 1. Revisions to the Contract Documents requested by the Owner or Architect.
 - 2. Specified options of products and construction methods included in the Contract Documents.
 - 3. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

1.4 SUBMITTALS

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- A. Substitutions During the Bidding Process: The Architect will consider requests for substitution if received 7 days prior to receipt of bids. Requests received less than 7 days prior to bid date may be considered or rejected at the discretion of the Architect.
1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and according to procedures required for change-order proposals.
 2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
 3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate contractors, that will be necessary to accommodate the proposed substitution.
 - b. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, color selection, durability, and visual effect.
 - c. Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
 - d. Samples, where applicable or requested.
 - e. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
 4. Architect's Action: If, in the Architect's professional judgement, the product substitution submitted is equal to that specified and will provide the Owner with equivalent value, service and maintainability, the Architect will accept it as an "Equal" and so inform bidders of this decision by Addendum.
 - a. The Architect's professional judgement in this matter shall be final. Substitutions not approved by Addendum shall not be considered approved. Oral approvals shall not be accepted.
- B. Substitutions After the Award of the Contract: The Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received more than 60 days after commencement of the Work may be considered or rejected at the discretion of the Architect.
1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and according to procedures required for change-order proposals.
 2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
 3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:

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- a. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate contractors, that will be necessary to accommodate the proposed substitution.
 - b. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, color selection, durability, and visual effect.
 - c. Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
 - d. Samples, where applicable or requested.
 - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost information, including proposal of the net change, if any in the Contract Sum.
 - e. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
4. Architect's Action: If necessary, the Architect will request additional information or documentation for evaluation within one week of receipt of a request for substitution. The Architect will notify the Contractor of acceptance or rejection of the substitution within 2 weeks of receipt of the request, or one week of receipt of additional information or documentation, whichever is later. Acceptance will be in the form of a change order or other written instruction. Should the Architect reject the substitution, use the product specified.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Conditions: The Architect will receive and consider the Contractor's request for substitution when one or more of the following conditions are satisfied, as determined by the Architect. If the following conditions are not satisfied, the Architect will return the requests without action except to record noncompliance with these requirements.
1. Extensive revisions to the Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of the Contract Documents and are beneficial to the Owner.
 3. The request is timely, fully documented, and properly submitted.
 4. The specified product or method of construction cannot be provided within the Contract Time. The Architect will not consider the request if the product or method

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cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

5. The request is directly related to an "or-equal" clause or similar language in the Contract Documents.
 6. The requested substitution offers the Owner a substantial advantage, in cost, time, energy conservation, or other considerations, after deducting additional responsibilities the Owner must assume. The Owner's additional responsibilities may include compensation to the Architect for redesign and evaluation services, increased cost of other construction by the Owner, and similar considerations.
 7. The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where the Contractor certifies that the substitution will overcome the incompatibility.
 8. The specified product or method of construction cannot be coordinated with other materials and where the Contractor certifies that the proposed substitution can be coordinated.
 9. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provides the required warranty.
- B. The Contractor's submittal and the Architect's acceptance of Shop Drawings, Product Data, or Samples for construction activities not complying with the Contract Documents do not constitute an acceptable or valid request for substitution, nor do they constitute approval.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 016200

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SECTION 01 70 00 - CONTRACT CLOSEOUT PROCEDURES |

PART 1) - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Project record document submittal.
 - 3. Operation and maintenance manual submittal.
 - 4. Submittal of warranties.
 - 5. Final cleaning.

- B. Related Sections include the following:
 - 1. Division 1 Section “Payment Procedures” for requirements for Applications for Payment for Substantial and Final Completion.
 - 2. Divisions 2 through 16 Sections for specific closeout and special cleaning requirements for products of those Sections.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request. |
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer’s name and model number where applicable.
 - 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner’s personnel of changeover in security provisions.
 - 8. Complete startup testing of systems.

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9. Submit test/adjust/balance records bearing the Architect's approval without exception.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, the Architect will proceed with inspection. The 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.

1.3 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following.

1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
2. Submit a certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, ad systems.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

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1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.

1.5 PROJECT RECORD DOCUMENTS |

- A. General: Do not use Project Record Documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the Architect's reference during normal working hours. |
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings.
 1. Mark Record Prints to show the actual installation where installation varies from that shown originally.
 2. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 4. Note Construction Change Directive numbers, RFI reference numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets. |

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- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy 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. Note related Change Orders, RFI notations, Record Drawings, and Product Data, where applicable.
- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
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 Drawings, and Record Specifications, where applicable.
- E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.6 OPERATION AND MAINTENANCE MANUALS

- A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data:
 - a. Emergency instructions and procedures.
 - b. System, subsystem & equipment descriptions, including operating standards.
 - c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
 - d. Description of controls and sequence of operations.
 - e. Piping diagrams.

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2. Maintenance Data:
 - a. Manufacturer's information, including list of spare parts.
 - b. Name, address, and telephone number of Installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, lock-tab type, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project Name, and subject matter of contents.

1.7 WARRANTIES

- A. Submittal Time: 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.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, 3-ring, lock-tab type, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8 ½ by 11 inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

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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 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner’s personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Provide instructors experienced in operation and maintenance procedures.
 - 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 - 3. Schedule training with Owner, with at least seven days’ advance notice.
 - 4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.
- B. Contractor to provide an agenda of instruction for each system.
- C. Contractor to provide an “Acknowledgement of instruction” sign-in sheet for each system. Submit triplicate copies for file.

3.2 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer’s written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and

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- other foreign deposits. Pressure wash as required to remove stains.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over “UL” and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grilles.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare and submit a written report for file.

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

END OF SECTION 01 70 00

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SECTION 01 78 36 - WARRANTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers standard warranties on products and special warranties.
 - 1. Refer to the General Conditions for terms of the Contractor's period for correction of the Work.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Product Requirements" specifies procedures for submitting warranties.
 - 2. Division 1 Section "Contract Closeout" specifies contract closeout procedures.
 - 3. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.
 - 4. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- C. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.3 DEFINITIONS

- A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide

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greater rights for the Owner.

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1.4 WARRANTY REQUIREMENTS

- A. **Related Damages and Losses:** When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.
- B. **Reinstatement of Warranty:** When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. **Replacement Cost:** Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. **Owner's Recourse:** Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - 1. **Rejection of Warranties:** The Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
- E. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the Owner reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

1.5 SUBMITTALS

- A. Submit written warranties to the Architect prior to the date certified for Substantial Completion. If the Architect's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Architect.
- B. When the Contract Documents require the Contractor, or the Contractor and a subcontractor, supplier or manufacturer to execute a special warranty, prepare a written document that contains appropriate terms and identification, ready for execution by the

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required parties. Submit a draft to the Owner, through the Architect, for approval prior to final execution.

- C. Form of Submittal: At Final Completion compile 2 copies of each required warranty properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. When warranted construction requires operation and maintenance manuals, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 78 36

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SECTION 03 30 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - (1) Division 2 Section "Sitework Concrete" and walks.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect.
- C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement.
- D. Laboratory test reports for concrete materials and mix design test.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."

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2. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- B. Concrete Testing Service: The Owner will engage a testing agency to perform material evaluation test cylinders at his expense.
- C. Materials and installed work will require retesting as directed by the Architect. Retesting of rejected materials and installed Work shall be done at Contractor's expense.

PART 2) - PRODUCTS

2.1 FORM MATERIALS

- A. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
- B. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- C. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches (38 mm) to the plane of the exposed concrete surface.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615 Grade 60 (ASTM A 615M Grade 400), deformed.
- B. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
- B. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
 1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.

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- C. Lightweight Aggregates: ASTM C330. Use lightweight concrete on elevated floor slabs.
- D. Pea-gravel Concrete: All concrete placed in concrete masonry units as masonry wall fill, in reinforced masonry walls, in walls with vertically reinforced corners and joints, and under all lintel or beam bearings shall be pea-gravel concrete having a minimum 28 day compressive strength of 3000 psi, minimum slump of 10", maximum coarse aggregate size of 3/8" and the mix shall be designed and placed in accordance with ASTM C 476 "Specifications for Mortar and Grout for Reinforced Masonry."
- E. Water: Potable.
- F. Fiber Reinforcement: Polypropylene fibers engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C 1116, Type III, not less than 3/4 inch long for slabs on grade only.
- G. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions. Use one of the following:
 - 1. Water-Reducing: ASTM C494, Type A.
 - a. W.R. Grace, WRDA-64
 - b. Master Builders, POZZOLITH 220N or MBL80
 - c. The Euclid Chemical Company, Eucon 11
 - 2. Water-Reducing and Retarding: ASTM C494, Type D.
 - a. W.R. Grace, DARATARD-37
 - b. Master Builders POZZOLITH 100, XR
 - c. The Euclid Chemical Company, Euco Retarder 100 or Euco Retarder 75
- H. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 - 1. Use one of the following:
 - a. W.R. Grace, Darex
 - b. The Euclid Chemical Company, Air Mix
 - c. Master Builders, Micro-Air
- I. Fly Ash: ASTM C618, Type C or F.
 - 1. Use when permitted by Architect.
 - 2. Limit use to not exceed 25% of cement content by weight.

2.4 RELATED MATERIALS

- A. Liquid Membrane-Forming Curing Compound: Liquid-type membrane-forming curing

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compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. m when applied at 200 sq. ft./gal (4.9 sq. m/L).

1. Use one of the following:
 - a. L & M Chemicals, Inc. Dress & Seal 30
 - b. Master Builders, Master Kure
 - c. Euclid Chemical Co., Super Rez-Seal VOX
 - d. Sonneborn Building Products, Kure-n-Seal 30

2.5 JOINT DEVICES AND FILLER MATERIALS

- A. Joint Filler ASTM D1751; Asphalt impregnated fiberboard or felt, ½ inch thick; tongue and groove profile.
- B. Construction Joint Devices for Slabs-On-Grade: Integral galvanized steel 24 gauge formed to tongue and groove profile, ribbed steel spikes with tongue to fit top screed edge.

2.6 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
 1. Retaining Walls: 4000 psi, 28-day compressive strength; water-cement ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained).
 2. Foundations, slabs on grade, elevated slabs, curbs, walks, pads and other areas: 3000 psi, 28-day compressive strength; water-cement ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained).
 - a. Use maximum aggregate size of 3/8" for fill in CMU walls, in bond beams or lintels, and under all beam or lintel bearing conditions.
- D. Fiber Reinforcement: Add at manufacturer's recommended rate but not less than 1.5 lb/cu. yd. (0.9 kg/cu. m). for slabs on grade only.

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2.7 ADMIXTURES

- A. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1 percent within the following limits:
 - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
 - a. 6.0 percent air content by volume.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
 - 1. When air temperature is between 85 deg F (29 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3) - EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits.
- B. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- C. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

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3.3 PLACING REINFORCEMENT

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

3.4 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.
- B. Provide keyways at least 1-1/2 inches (38 mm) deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as foundation walls, grade beams, and other locations, as indicated.

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- F. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch (3 mm) wide by one-fourth of slab depth or inserts 1/4 inch (6 mm) wide by one-fourth of slab depth, unless otherwise indicated.
1. Form contraction joints in slabs to be left exposed by inserting pre-molded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
 3. If joint pattern is not shown, provide joints not exceeding 15 ft. (4.5 m) in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

3.5 PREPARING FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, non-residual, low-VOC, form-coating compound before placing reinforcement.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.
- D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position on chairs during concrete placement.

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- E. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

3.7 MONOLITHIC SLAB FINISHES

- A. Trowel Finish: Apply a trowel finish to monolithic interior slab surfaces.
- B. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.8 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.
- C. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
- D. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:
1. Apply curing compound to concrete slabs as soon as final finishing operations are

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complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

3.9 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.

B. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
4. Repair defective areas, except random cracks and single holes not exceeding 1 inch (25 mm) in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

3.10 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. General: The Owner will employ a testing agency to perform tests and to submit test reports.

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- B. Sampling and testing for quality control during concrete placement may include the following, as directed by Architect.
1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 - d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. (4 cu. m) plus additional sets for each 50 cu. yd. (38 cu. m) more than the first 25 cu. yd. (19 cu. m) of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).
- C. Test results will be reported in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

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- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION 03300

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3.5 PREPARING FORM SURFACES

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3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
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 - 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
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- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.
- C. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
- D. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:
 - 1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
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smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
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 - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature

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is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.

- d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. (4 cu. m) plus additional sets for each 50 cu. yd. (38 cu. m) more than the first 25 cu. yd. (19 cu. m) of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).
- C. Test results will be reported in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION 03 30 00

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SECTION 03 41 00 - PLANT-PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

3.1 SECTION REQUIREMENTS

- A. Engineer, fabricate, and install structural precast concrete floor planks to withstand design loadings indicated.
- B. Calculate fire resistance according to ASTM E 119 and PCI's "Design for Fire Resistance of Precast Prestressed Concrete."
- C. Submittals: Product Data, Shop Drawings, structural analysis data, and calculated fire-resistance requirements signed and sealed by a qualified professional engineer.
- D. Comply with PCI's "PCI Design Handbook--Precast and Prestressed Concrete," PCI's "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products," AWS D1.1, and AWS D1.4.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Deformed Reinforcing Bars: ASTM A 615, Grade 60 (ASTM A 615M, Grade 420).
- B. Steel Wire: ASTM A 82, plain, cold drawn.
- C. Steel-Welded Wire Fabric: ASTM A 185, plain, cold drawn.
- D. Deformed-Steel-Welded Wire Fabric: ASTM A 497, cold drawn.
- E. Prestressing Strand: ASTM A 416, Grade 250 or 270 (ASTM A 416M, Grade 1725 or 1860), uncoated, 7-wire, low-relaxation strand.
- F. Portland Cement: ASTM C 150, Type I or Type III.
- G. Fly Ash: ASTM C 618, Class C or F.
- H. Silica Fume: ASTM C 1240, amorphous silica.
- I. Normal-Weight Aggregates: ASTM C 33, Class 4S.

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- J. Air-Entraining Admixture: ASTM C 260.
- K. Chemical Admixtures: ASTM C 494, water reducing, or water reducing and accelerating, as determined by manufacturer. Do not use admixtures containing chlorides.

2.2 ACCESSORIES AND FINISHES

- A. Steel Shapes and Plates: ASTM A 36 (ASTM A 36M).
- B. Bolts and Studs: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex- head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.
 - 1. Hot-dip galvanize steel items adjacent to or exposed to the exterior according to ASTM A 153.
 - 2. Shop-Primed Finish: Prepare surfaces of steel items according to SSPC-SP 3 and shop-apply fast-curing, lead- and chromate-free, VOC-conforming, universal modified-alkyd primer according to SSPC-PA 1.
- C. Bearing Pads: AASHTO M 251, elastomeric, plain, vulcanized; 50 to 70 Shore A durometer hardness.
- D. Grout: ASTM C 150, Type I, portland cement, water, and clean, natural sand.

2.3 CONCRETE MIX

- A. Proportion normal-weight concrete mixes to provide the following properties:
 - 1. Compressive Strength: 5000 psi (34.5 MPa) at 28 days, or as required to meet design loads.
 - 2. Water-Cementitious Materials Ratio: 0.40 maximum.
 - 3. Air Content: 5.5 to 7.5 percent for concrete exposed to freezing and thawing, 2.5 to 4.5 percent elsewhere.
- B. Concrete Mixing: Comply with ASTM C 94.
- C. Finishes: Standard for formed surfaces. Scratch finish unformed surfaces to receive concrete topping.
- D. Replace precast concrete planks deficient in strength, manufacturing tolerances, and finishes.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install bearing pads true, level, and on uniform bearing surfaces.
- B. Protect precast planks and bearing pads from damage during welding.
- C. Install precast planks level, plumb, square, and true, within the recommended erection tolerances of PCI's "Recommended Practice for Erection of Precast Concrete."
- D. Shore and brace precast concrete planks to maintain location, stability, and alignment until permanent connections are installed.
- E. Grout open spaces at keyways, connections, and joints after precast concrete planks have been placed and secured.
- F. Clean exposed surfaces of precast concrete planks after erection.

END OF SECTION 03 41 00

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SECTION 04 20 00 - UNIT MASONRY

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:

1. Concrete unit masonry.
2. Insulation in masonry walls.
3. Mortar and grout.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Masonry accessories.
8. Glass Block

- B. Related Sections include the following:

1. Division 7 Section "Bituminous Dampproofing"

- C. Products installed but not furnished under this Section include the following:

1. Steel lintels and shelf angles for unit masonry specified in Division 5 Section "Metal Fabrications."
2. Manufactured reglets in masonry joints for metal flashing specified in Division 7 Section "Flashing and Sheet Metal."
3. Hollow metal frames in unit masonry openings specified in Division 8 Section "Steel Doors and Frames."

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each different masonry unit, accessory, and other products specified.

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1.4 QUALITY ASSURANCE

- A. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.
 - B. Single-Source Responsibility 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 one source and by a single manufacturer for each different product required.
 - C. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
- 2. Build mockups for typical exterior CMU wall approximately 48 inches long by 48 inches high by full thickness, including accessories.
 - 3. Clean exposed faces of mockups with masonry cleaner indicated.
 - 4. Notify Architect one week in advance of the dates and times when mockups will be constructed.
 - 5. Protect accepted mockups from the elements with weather-resistant membrane.
 - 6. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - a. Acceptance of mockups 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.
 - b. When directed, demolish and remove mockups from Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not install until they are in an air-dried condition.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

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1.6 PROJECT CONDITIONS

- A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit masonry damaged by frost or freezing conditions. Comply with the following requirements:
 - 1. Cold-Weather Construction: When the ambient temperature is within the limits indicated, use the following procedures:
 - a. 40 to 32 deg F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F.
 - b. 32 to 25 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry.
 - c. Below 25 deg F: Do not lay masonry unless directed so by Architect, taking precautions as directed by Architect.
 - 2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection:
 - a. 40 to 25 deg F: Cover masonry with a weather-resistant membrane for 48 hours after construction.
 - b. 25 to 20 deg F: Cover masonry with insulating blankets or provide enclosure and heat for 48 hours after construction to prevent freezing. Install wind breaks when wind velocity exceeds 15 mi./h.
 - c. 20 deg F and Below: Provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after construction.
 - 3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried out, but not less than 7 days after completion of cleaning.

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- E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and above.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. General: Provide shapes indicated and as follows:
1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
 2. Provide bullnose units for all interior outside corners, unless otherwise indicated.
- B. Concrete Masonry Units: ASTM C 90 and as follows:
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 Mpa).
 2. Weight Classification: Lightweight.
 3. Provide Type II, nonmoisture-controlled units.
 4. Size: Manufactured to the actual dimensions listed below (within tolerances specified in the applicable referenced ASTM specification) for the corresponding nominal sizes indicated on Drawings:
 - a. 4 inch nominal: 3-5/8 inch actual.
 - b. 6 inch nominal: 5-5/8 inch actual.
 - c. 8 inch nominal: 7-5/8 inch actual.
 - d. 10 inch nominal: 9-5/8 inch actual.
 - e. 12 inch nominal: 11-5/8 inch actual.
 - f. 16 inch nominal: 15-5/8 inch actual.
 5. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
- C. Decorative Concrete Masonry Units: ASTM C 90; Weight Classification, Lightweight or Medium Weight; Type I, moisture-controlled units.
1. Type: Exposed faces with split-face texture. Natural gray color.
 2. Integral Water Repellent: Block Plus W-10; Addiment, Dry-Block, W.R. Grace & Co., or Rheopel, Master Builders.
 3. Special shapes for lintels, corners, jambs, sash, control joints, and other special conditions.
 4. Concrete masonry units shall be integrally colored with color and textured selected by Architect from manufacturers full range of colors and textures.

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- D. Concrete Building Brick: ASTM C 55 and as follows:
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength indicated below:
 2. Provide Type I, moisture-controlled units.
 3. Size: Manufactured to specified dimensions within tolerances specified in the applicable referenced ASTM specification as follows:
 - a. Modular: 3-5/8 inches thick by 2-1/4 inches high by 7-5/8 inches long.
 4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

2.2 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction
- B. Mortar Cement: U.B.C. Standard No. 21-14.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.
- E. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch (6.5 mm), use aggregate graded with 100 percent passing the No. 16 (1.18 mm) sieve.
- F. Aggregate for Grout: ASTM C 404.
- G. Water: Potable.

2.2 JOINT REINFORCEMENT

- A. General: Provide joint reinforcement formed from the following:
1. Galvanized carbon-steel wire, coating class as follows:
 - a. ASTM A 641 (ASTM A 641M), Class 1, for interior walls; and ASTM A 153, Class B-2, for exterior walls.
 - b. ASTM A 153, Class B-2, for both interior and exterior walls.
- B. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with prefabricated corner and tee units, and complying with requirements indicated below:
1. Wire Diameter for Side Rods: 0.1483 inch.
 2. Wire Diameter for Cross Rods: 0.1483 inch.

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C. For single-wythe masonry, provide type as follows with single pair of side rods:

1. Ladder design with perpendicular cross rods spaced not more than 16 inches o.c.

2.3 TIES AND ANCHORS, GENERAL

A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of this Article, unless otherwise indicated.

B. Wire: As follows:

1. Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating for wire ties and anchors in exterior walls.
2. Wire Diameter: 0.1875 inch.

2.6 ANCHORS FOR CONNECTING TO CONCRETE

A. General: Provide two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section: Dovetail anchor section formed from 0.034 inch (0.85 mm) thick, steel sheet, mill galvanized.
2. Tie Section: Traingular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.1875 inch (4.8 mm) diameter, hot-dip galvanized steel wire.

2.7 ADJUSTABLE ANCHORS FOR CONNECTING TO STRUCTURAL FRAME

A. General: Provide 2-piece assemblies as described below, allowing vertical or horizontal differential movement between wall and frame parallel to plane of wall but resisting tension and compression forces perpendicular to it.

1. For anchorage to steel framing, provide manufacturer's standard anchors with crimped 1/4-inch- diameter wire anchor section for welding to steel and triangular-shaped wire tie section sized to extend within 1 inch of masonry face and as follows:
 - a. Wire Diameter: 0.1875 inch.

2.8 EMBEDDED FLASHING MATERIALS

A. Thru-wall Laminated Flashing: Manufacturer's standard laminated flashing of type indicated below:

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1. Copper-Fabric Laminate: Copper sheet weighing 5 oz./sq.ft., bonded with asphalt between 2 layers of asphalt-impregnated glass-fiber cloth.
 2. Application: Use where flashing is fully concealed in masonry.
- B. Adhesive for Flashings: Of type recommended by manufacturer of flashing material for use indicated.
- C. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
1. Thru-Wall Copper-Fabric Laminate Flashing:
 - a. Copper Fabric; AFCO Products, Inc.
 - b. Copper Fabric Flashing; Sandell Manufacturing Co., Inc.
 - c. York Copper Fabric Flashing; York Manufacturing, Inc.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded neoprene filler strips complying with ASTM D 1056, Type 2, Class A, Grade 1; compressible up to 35 percent; 3" width, install vertically in face CMU control joints.

2.10 INSULATION

- A. Foam-In-Place Masonry Insulation: Foam insulation equal to Core-Fill 500 by Tailored Chemical Products. R-value of 4.9/inch.

2.11 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of ½ cup (0.14 L) dry measure tetrasodium polyphosphate and ½ cup (0.14L) dry measure laundry detergent dissolved in 1 gal (4 L) of water.

2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:
1. Limit cementitious materials in mortar to portland cement and lime.

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2. For masonry below grade, in contact with earth, and where indicated, use type indicated below:
 - a. Type: S or RS.

3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions, and for other applications where another type is not indicated, use type indicated below:

- a. Type: N or RN.

- C. Grout for Unit Masonry: Comply with ASTM C 476. Use grout of consistency indicated or, if not otherwise indicated, of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.

1. Use fine grout in grout spaces less than 2 inches in horizontal dimension, unless otherwise indicated.
2. Use coarse grout in grout spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.

2.13 GLASS BLOCK

- A. Glass Block shall be equal to “Decora” pattern by Pittsburgh Corning, nominal 8” x 8” x 4” thick size.
- B. Use hot-dipped, ladder-type reinforcing for glass block. Expansion Strips: 3/8 x 4 in (9.5 x 102 mm) open cell polyethylene foam or glass fiber.
- C. Mortar for glass block shall be prepared according to ASTM C270 for Type S Mortar consisting of:
 - a. Portland Cement (Type 1): 1 part.
 - b. Lime: 1 part.
 - c. Fine Sand: 2-12 to 3 parts. Sand passing No. 20 sieve and free of iron compounds to avoid stains.

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 unit masonry. Do not proceed with installation until unsatisfactory conditions have been corrected.

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- B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of thickness indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections of the Specifications.
- C. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting, where possible. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- D. Mix units for exposed unit masonry from several pallets or cubes as they are placed to produce uniform blend of colors and textures.

3.3 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of columns, walls, and arises, do not exceed 1/4 inch in 10 feet, nor 3/8 inch in 20 feet, nor 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet, nor 1/2 inch maximum.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet, nor 1/2 inch in 40 feet or more. For top surface of bearing walls, do not exceed 1/8 inch in 10 feet, nor 1/16 inch within width of a single unit.
- C. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls, and partitions, do not exceed 1/2 inch in 20 feet, nor 3/4 inch in 40 feet or more.
- D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4 inch nor plus 1/2 inch.
- E. Variation in Mortar-Joint Thickness: Do not vary from bed-joint thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary bed-joint thickness from bed-joint thickness of adjacent course by more than 1/8 inch. Do not vary from head-joint thickness indicated by more than plus or minus 1/8

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inch. Do not vary head-joint thickness from adjacent head-joint thickness by more than 1/8 inch. Do not vary from collar-joint thickness indicated by more than minus 1/4 inch or plus 3/8 inch.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.
- B. Lay walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bond Pattern for Exposed Masonry: Lay exposed masonry in running bond pattern and other pattern shown on drawings. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs. Use colored mortar for all exposed Split-Face CMU walls.
- D. Lay concealed masonry with all units in a wythe in running bond. 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. Use natural colored mortar for CMU walls.
- E. Stopping and Resuming Work: In each course, rack back 1/2-unit length for one-half running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar prior to laying fresh masonry.
- F. Built-in Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
- G. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
- H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above and as follows:
- J. Install compressible filler in joint between top of partition and underside of structure above.
- K. Fill cavities of all CMU below grade with 2000 pound strength concrete.

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- L. Split-Face CMU: Tool joints as required to bridge the alignment of the block faces.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
 - 2. With full mortar coverage on horizontal and vertical face shells.
 - 3. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
 - 4. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
 - 5. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 3/8-inch (10-mm) joints.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.6 HORIZONTAL-JOINT REINFORCEMENT

- B. General: Provide continuous horizontal-joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcing a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c. vertically.
 - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement in mortar joint 1 block course above and below wall openings and extending 12 inches beyond opening.
 - a. Reinforcement above is in addition to continuous reinforcement.
- C. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- D. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 INSTALLATION OF GLASS BLOCK

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A. Install products in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction and the following:

1. Coat sill under units with asphalt emulsion as a bond breaker.
2. Set first course in a full mortar bed. All mortar joints must be filled solid with mortar. Furrowing is not permitted. Neatly tool surface to a concave joint.
3. Place panel reinforcing in horizontal joint above first course of block and then every other course.
4. Isolate panel from frame on sides and top with expansion strips. Keep expansion joint voids clear of mortar.
5. Maintain uniform joint width with maximum variation of panel from plane to be 1/16 in.
6. Do not use retempered mortar. Do not tap glass block with steel tools.
7. When mortar has set, pack backer rod in jamb and head channels. Recess to allow for sealant.

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joints in unit masonry where indicated. Build-in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and where openings of more than 24 inches for block size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.10 FLASHING AND VENTS

- A. General: Install embedded flashing in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
- B. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer before covering with mortar.

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- C. Install flashing as follows:
1. At composite masonry walls, extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches, and through the inner wythe to within ½ inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.
 2. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. At heads and sills, extend flashing 4 inches at ends and turn up not less than 2 inches to form a pan.
 3. Interlock end joints of sawtooth sheet-metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements of Division 7 Section "Joint Sealants" for application indicated.
 4. Extend sheet-metal flashing ½ inch beyond face of masonry at precast parapets and turn down to form a drip.
 5. Cut off thru-wall flashing flush with face of wall after masonry wall construction is completed.
- D. Install reglets and nailers for flashing and other related construction where shown to be built into masonry.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units; install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point-up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for application of sealants.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears prior to tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

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3. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 4. Wet wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
 5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain present on exposed surfaces.
- E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.12 MASONRY WASTE DISPOSAL

- A. Recycling: Undamaged, excess masonry materials are Contractor's property and shall be removed from the Project site for his use.
- B. Excess Masonry Waste: Remove masonry waste and legally dispose of off Owner's property.

END OF SECTION 04 20 00

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SECTION 05 10 00- STRUCTURAL STEEL

PART 1) - GENERAL

a) RELATED DOCUMENTS

- i) Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

b) SUMMARY

- i) This Section includes structural steel.
- ii) Related Sections: The following Sections contain requirements that relate to this Section:
 - (1) Division 1 Section "Quality Control" for independent testing agency procedures and administrative requirements.
 - (2) Division 5 Section "Steel Deck" for field installation of shear connectors.
 - (3) Division 5 Section "Metal Fabrications" for loose steel bearing plates and miscellaneous steel framing.
 - (4) Division 9 Section "Painting" for surface preparation and priming requirements.

c) PERFORMANCE REQUIREMENTS

- i) Structural Performance: Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.
- ii) Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

d) SUBMITTALS

- i) General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- ii) Product Data for each type of product specified.
- iii) Shop Drawings detailing fabrication of structural steel components.
 - (1) Include details of cuts, connections, splices, camber, holes, and other pertinent data.

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- (2) Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - (3) Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.
 - (4) Include Shop Drawings signed and sealed by a qualified professional engineer responsible for their preparation.
- iv) Mill test reports signed by manufacturers certifying that their products, including the following, comply with requirements.
- (1) Structural steel, including chemical and physical properties.
 - (2) Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 - (3) Direct-tension indicators.
 - (4) Shear stud connectors.
 - (5) Shop primers.
 - (6) Nonshrink grout.

e) QUALITY ASSURANCE

- i) **Installer Qualifications:** Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- ii) **Fabricator Qualifications:** Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.
- iii) Comply with applicable provisions of the following specifications and documents:
 - (1) AISC's Specification for Structural Steel Buildings--Design, Fabrication and Erection.
 - (2) Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - (3) Research Council on Structural Connections' (RCSC) "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- iv) **Professional Engineer Qualifications:** A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with steel stair construction that are similar to that indicated for this Project in material, design, and extent.

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- v) Nonhigh-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers.

- (1) Finish: Plain, uncoated.

- vi) High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

- (1) Finish: Plain, uncoated.

- vii) Welding Electrodes: Comply with AWS requirements, ASTM A 233, Series E 70.

I. Shear Connectors (Shear Studs)

- 1. Stud Shear Connectors shall be AWS D1.1 "Type B" headed studs made from ASTM A108, Grade 1015 or 1020, cold-finished carbon steel, with dimensions complying with AWS D1.1 for the type and sizes shown.

f) PRIMER

- i) Primer: Do not shop prime structural steel.
- ii) Anchors: Asphalt paint coating for anchors built into masonry.

g) GROUT

- i) Metallic, Shrinkage-Resistant Grout: Premixed, factory-packaged, ferrous aggregate grout, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

h) FABRICATION

- i) Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.
 - (1) Mark and match-mark materials for field assembly.
 - (2) Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
 - (3) Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

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- ii) Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - (1) Plane thermally cut edges to be welded.
- iii) Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.

PART 2) - EXECUTION

a) EXAMINATION

- i) Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.
- ii) Do not proceed with erection until unsatisfactory conditions have been corrected.

b) PREPARATION

- i) 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.

c) ERECTION

- i) Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
- ii) Do not use thermal cutting during erection.
- iii) Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

d) FIELD CONNECTIONS

- i) Install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.
- ii) Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - (1) Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension,

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or tensioned shear/bearing connections.

e) FIELD QUALITY CONTROL

- i) Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 - (1) Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- ii) Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- iii) Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

END OF SECTION 05 10 00

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SECTION 05 44 00 - PRE-ENGINEERED COLD-FORMED STEEL TRUSSES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Pre-engineered Cold-Formed steel trusses.
- B. Cold-formed steel framing accessories.

1.2 DEFINITIONS

- A. Truss Component Manufacturer: The maker of the components that will be assembled into trusses by the Truss Manufacturer. See MANUFACTURERS for acceptable Truss Component Manufacturer.
- A. Truss Manufacturer: An individual or organization engaged in the manufacturing of trusses. See MANUFACTURERS for acceptable Truss Manufacturers.
- B. Truss Design Drawing: Written, graphic and pictorial depiction of an individual truss.
- C. Truss Design Engineer: Person who is licensed to practice engineering as defined by the legal requirements of the jurisdiction in which the building is to be constructed and who supervises the preparation of the truss design drawings. In this case, the Truss Design Engineer is the Truss Component Manufacturer.
- D. Truss Placement Diagram: Illustration identifying the assumed location of each Truss.

1.3 REFERENCES

- A. ANSI/AISI/ S100-2012: North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012 edition.
- B. ANSI/AISI /S200-12: North American Standard for Cold-Formed Steel Framing - General Provisions; 2012 edition.
- C. ANSI/AISI/S202-11: Code of Standard Practice for Cold-Formed Steel Structural Framing; 2011 edition.
- D. ANSI/AISI /S214-12: North American Standard for Cold-Formed Steel Framing - Truss Design; 2012 edition.
- E. ASTM A 370-14 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products; 2014.
- F. ASTM A 500-13 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
- G. ASTM A 653-15 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.

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- H. ASTM A 780-09 (2015) – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings; 2009 and reapproved in 2015.
- I. CFSBCSI - Cold-Formed Steel Building Components Safety Information; Cold-Formed Steel Council (CFSC); 2008 edition with insert for Modifications to Chapters CFSB1, B2, & B3.
- J. CFSEI Technical Note 551e - Design Guide for Permanent Bracing of Cold-Formed Steel Trusses; Cold-Formed Steel Engineers Institute; February 1998.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 (Section 01300 IN MF95).
- B. Product Data: Truss Component Manufacturer's descriptive literature for each item of cold-formed metal framing and each accessory specified in this section.
- C. Truss Design Drawings: Detailed drawings prepared by Truss Manufacturer under the supervision of the Truss Design Engineer that are in accordance with AISI references. These drawings may also include referenced detail drawings germane to the trusses
- D. Truss Placement Diagram: Diagram that identifies the assumed location of each individually designated truss and references the corresponding Truss Design Drawing.
- E. Installation Instructions: Truss Component Manufacturer's printed instructions for handling, storage, and installation of each item of cold-formed metal framing and each accessory specified in this section.

1.5 QUALITY ASSURANCE

- A. Provide design of trusses by Truss Component Manufacturer, using design methodologies recommended in AISI references.
 - 1. Determine mechanical properties of load bearing components by testing in accordance with ASTM A 370-14.
 - 2. Provide drawings by a Registered Design Professional licensed in the State in which project is to be constructed.
 - 3. Provide Truss Manufacturer's Truss Design Drawings.
- B. Pre-Installation Meeting: Meet at job site prior to scheduled beginning of installation to review requirements:
 - 1. Attendees: Require attendance by representatives of the following:
 - a. Installer of this section.
 - b. Other entities directly affecting, or affected by, construction activities of this section, including but not limited to, the following:
 - 1. Installer of truss support framing.
 - 2. Installer of mechanical systems.
 - 3. Installer of electrical systems.

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2. Review potential interface conflicts; coordinate layout and support provisions.

1.6 DELIVERY, STORAGE, AND HANDLING OF STEEL TRUSSES

- A. Pack, ship, handle, unload, and lift shop products in accordance with Truss Component Manufacturer's recommendations and in manner necessary to prevent damage or distortion.
- B. Store and protect products in accordance with Truss Component Manufacturer's recommendations and in manner necessary to prevent damage, distortion and moisture buildup.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Standard of Quality Truss Component Manufacturer: TrusSteel Products from Alpine TrusSteel, An ITW Company; 2400 Lake Orange Dr, Ste 150, Orlando, FL 32837. Tel: (888) 565-9181. www.TrusSteel.com.
- B. Alternate Acceptable Truss Manufacturers: Manufacturers meeting the design and quality standards specified herein shall be accepted.
- C. Truss Manufacturers: Truss components shall be fabricated into completed trusses by fabricators that have at least 5 years worth of experience in the design and supply of Cold-Formed Steel Trusses.

2.2 COMPONENTS

- A. Pre-Engineered, Pre-Fabricated Cold-Formed Steel Trusses: TrusSteel truss components by Alpine TrusSteel, An ITW Company, meeting specified requirements.
 1. Truss Type, Span, and Height: As indicated on drawings.
 2. Comply with requirements of current Virginia Construction Code.
 3. Deflection Under All Loads: 1/360th of span, maximum.
 4. Deflection Under Live Loads: 1/480th of span, maximum.
 5. Shop fabricate in accordance with Truss Design Drawings, using jiggling systems to ensure consistent component placement and alignment of components, and to maintain specified tolerances; field fabrication is strictly prohibited unless performed by authorized Truss Manufacturer using Truss Manufacturer's shop assemblers and proper jiggling systems.
 6. Shop fabrication of other cold-formed steel framing components into assemblies prior to erection is permitted; fabricate assemblies in accordance with shop drawings.
 7. Fasten connections within truss assembly with Truss Component Manufacturer's screws only and as shown on the Truss Design Drawings; welding and other fasteners are prohibited.

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8. Fabricate straight, level, and true, without rack, and to the tolerances specified in ANSI/AISI /S214-12:
- B. Truss Chord and Web Components: All truss components to be symmetrical in profile and loading orientation, with rolled or closed edges to minimize the danger of cutting during handling; chord and web components without rolled edges are prohibited.
1. Shapes, Sizes, and Thicknesses: As required to suit design and as indicated on shop drawings.
 2. Chords: Cold-formed from ASTM A 653/A 653M galvanized steel sheet, minimum G60 coating; minimum yield strength of 55,000 psi (380 MPa) for 22, 20, 18 and 16 GA components or 50,000 psi (345 MPa) for 14 GA and 12 GA components; minimum tensile strength of 65,000 psi (448 MPa) for 22, 20, 18, 16, 14, and 12 GA components.
 - a. Nominal 28 mil (22 GA) members:
 1. Minimum bare metal thickness: 0.0284 inch (0.72 mm).
 2. Maximum design thickness: 0.0299 inch (0.76 mm).
 - b. Nominal 33 mil (20 GA) members:
 1. Minimum bare metal thickness: 0.0329 inch (0.84 mm).
 2. Maximum design thickness: 0.0346 inch (0.88 mm).
 - c. Nominal 43 mil (18 GA) members:
 1. Minimum bare metal thickness: 0.0428 inch (1.09 mm).
 2. Maximum design thickness: 0.0451 inch (1.15 mm).
 - d. Nominal 54 mil (16 GA) members:
 1. Minimum bare metal thickness: 0.0538 inch (1.37 mm).
 2. Maximum design thickness: 0.0566 inch (1.44 mm).
 - e. Nominal 68 mil (14 GA) members:
 1. Minimum bare metal thickness: 0.0677 inch (1.72 mm).
 2. Maximum design thickness: 0.0713 inch (1.81 mm).
 - f. Nominal 97 mil (12 GA) members:
 1. Minimum bare metal thickness: 0.0966 inch (2.46 mm).
 2. Maximum design thickness: 0.1017 inch (2.58 mm).
 3. Tube Webs: Cold-formed ASTM A500 steel structural tubing; minimum yield strength of 45,000 psi (310 MPa); minimum tensile strength of 55,000 psi (380 MPa).
 - a. Nominal 33 mil (20 GA) members:
 1. Minimum bare metal thickness: 0.033 inch (0.84 mm).
 2. Maximum design thickness: 0.035 inch (0.89 mm).
 - b. Nominal 47 mil (18 GA) members:

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1. Minimum bare metal thickness: 0.047 inch (1.19 mm).
 2. Maximum design thickness: 0.049 inch (1.24 mm).
- c. Nominal 63 mil (16 GA) members:
1. Minimum bare metal thickness: 0.063 inch (1.6 mm).
 2. Maximum design thickness: 0.065 inch (1.65 mm).
4. Rolled formed Webs: Cold-formed from ASTM A 653/A 653M galvanized steel sheet, minimum G60 coating; minimum yield strength of 40,000 psi (276 MPa) for 20 and 18 GA components or 50,000 psi (345 MPa) for 16 GA components; minimum tensile strength of 55,000 psi (379 MPa) for 20 and 18 GA components or 65,000 psi (448 MPa) for 16 GA components.
- a. Nominal 33 mil (20 GA) members:
1. Minimum bare metal thickness: 0.0329 inch (0.84 mm).
 2. Maximum design thickness: 0.0346 inch (0.88 mm).
- b. Nominal 43 mil (18 GA) members:
1. Minimum bare metal thickness: 0.0428 inch (1.09 mm).
 2. Maximum design thickness: 0.0451 inch (1.15 mm).
- c. Nominal 54 mil (16 GA) members:
1. Minimum bare metal thickness: 0.0538 inch (1.37 mm).
 2. Maximum design thickness: 0.0566 inch (1.44 mm).
- C. Fasteners Used in Fabricating Trusses: Fasteners as recommended by Truss Component Manufacturer, bearing stamp of Truss Component Manufacturer for ready identification.

2.3 DESIGN CRITERIA

- A. Design Criteria are as follows:
1. Roof Live (snow) Load: 30 PSF (plus drift)
 2. Live Load – Bottom chord: 0 PSF
 3. Dead Load – Top chord: 10 PSF plus
 4. Dead Load Bottom Chord: 10 PSF
 5. Dead Load Trusses & Bracing: Per Manufacturer
 6. Wind Load: per 2015 Virginia Construction Code
 7. Basic Wind Speed: 115 MPH (Vs3) Ultimate
 8. Exposure Category: B
 9. Importance Factor: 1.0

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that bearing surfaces and substrates are ready to receive steel trusses.

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- B. Verify that truss bearing surfaces are within the following tolerances:
 - 1. Variation from Level or Specified Plane: Maximum 1/8 inch in 10 feet.
 - 2. Variation from Specified Position: Maximum 1/4 inch.
- C. Verify that rough-in utilities and chases that will penetrate plane of trusses are in correct locations and do not interfere with truss, bracing, or bridging placement.
- D. Inspect conditions under which installation is to be performed and submit written notification if such conditions are unacceptable to installer.
 - 1. Notify Architect/Building Designer within 24 hours of inspection.
 - 2. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.
 - 3. Beginning construction activities of this section indicates installer's acceptance of conditions.

3.2 INSTALLATION

- A. Install trusses in accordance with Truss Component Manufacturer's instructions and Truss Manufacturer's Truss Design Drawings and Truss Placement Diagram. Use correct fasteners as previously described.
- B. Place components at spacings indicated on the Truss Design Drawings.
- C. Install all erection (temporary installation) bracing and permanent bracing and bridging before application of any loads; follow recommendations of the CFSBCSI - Cold-Formed Steel Building Components Safety Information.
- D. Install erection bracing - follow recommendations of the CFSBCSI - Cold-Formed Steel Building Components Safety Information.
 - 1. Provide bracing that holds trusses straight and plumb and in safe condition until decking and permanent truss bracing has been fastened to form a structurally sound framing system.
 - 2. All sub-contractors shall employ proper construction procedures to insure adequate distribution of temporary construction loads so that the carrying capacity of any single truss or group of trusses is not exceeded.
- E. Install permanent bracing and bridging as shown in the Architect/Building Designer's drawings and notes and in the locations shown on the Truss Manufacturer's Truss Design Drawings.
- F. Removal, cutting, or alteration of any truss chord, web or bracing member in the field is prohibited, unless approved in advance in writing by the Architect/Building Designer and the Truss Design Engineer.
- G. Repair or replace damaged chords, webs, and complete trusses as directed and approved in writing in advance by the Architect/Building Designer and the Truss Component Manufacturer.

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3.3 FIELD QUALITY CONTROL

A. Owner will provide inspection service to inspect field connections.

3.4 REPAIRS AND PROTECTION

A. Galvanizing repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to the manufacturer and installer, that ensure the cold-formed steel trusses are without damage or deterioration at the time of substantial completion.

END OF SECTION

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SECTION 05 50 00 - METAL FABRICATIONS

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 metal fabrications:
 - 1. Rough hardware.
 - 2. Ladders.
 - 3. Loose bearing and leveling plates.
 - 4. Loose steel lintels.
 - 5. Shelf and relieving angles.
 - 6. Miscellaneous framing and supports for the following:
 - a. Framing and Guards around balcony
 - b. Framing and supports for mechanical and electrical equipment.
 - c. Framing and curb supports for roof hatches.
 - d. Applications where framing and supports are not specified in other sections.
 - 7. Miscellaneous steel trim.
 - 8. Accordion security doors.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 5 Section "Structural Steel" for structural steel framing system components.
 - 2. Division 5 Section "Metal Stairs" and pipe railings for metal framed stairs with metal pan, metal plate, or grating treads and metal pipe and tube handrails and railing systems.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.

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Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

- C. Samples representative of materials and finished products as may be requested by Architect.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the Work.
- B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel," and AWS D1.3 "Structural Welding Code--Sheet Steel."

1.5 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for and perform necessary trimming and fitting.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- B. Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).
- C. Steel Tubing: Product type (manufacturing method) and as follows:
 - 1. Cold-Formed Steel Tubing: ASTM A 500.
 - 2. Hot-Formed Steel Tubing: ASTM A 501.
 - a. Where indicated, provide tubing with hot-dip galvanized coating per ASTM A 53.

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- D. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or another weight required by structural loads.
 - 1. Black finish, unless otherwise indicated.
 - 2. Galvanized finish where indicated.
- E. Malleable-Iron Castings: ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010).
- F. Welding Rods and Bare Electrodes: Select according to AWS specifications for the metal alloy to be welded.

2.2 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.
- C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.

2.3 FASTENERS

- A. General: Provide plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating, for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.
- B. Machine Screws: ANSI B18.6.3 (ANSI B18.6.7M).
- C. Lag Bolts: ANSI B18.2.1 (ANSI B18.2.3.8M).
- D. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Material: Carbon steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

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2.4 FABRICATION, GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Remove sharp or rough areas on exposed traffic surfaces.
- F. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- I. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- J. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

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- K. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.5 ROUGH HARDWARE

- A. Furnish bent, or otherwise custom-fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 Sections.
- B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts that bear on wood structural connections, and furnish steel washers elsewhere.

2.6 STEEL LADDERS

- A. General: Fabricate ladders for the locations shown, with dimensions, spacings, details, and anchorages as indicated. Comply with requirements of ANSI A14.3. Elevator pit ladders shall comply with ASME A17.1.
- B. Siderails: Continuous, steel, 3/8-by-2-1/2-inch flat bars, with eased edges, spaced 18 inches apart.
- C. Bar Rungs: 3/4-inch- diameter steel bars, spaced 12 inches o.c.
- D. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
- E. Support each ladder at top and bottom and at intermediate points spaced not more than 60 inches o.c. with welded or bolted steel brackets.
 - 1. Size brackets to support design dead and live loads indicated in ANSI A14.3 and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.
 - 2. Extend side rails 42 inches above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.
- F. Provide nonslip surfaces on top of each rung, either by coating the rung with aluminum-oxide granules set in epoxy-resin adhesive, or by using a type of manufactured rung that is filled with aluminum-oxide grout.
- G. Galvanize ladders, including brackets and fasteners, in exterior locations.

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2.7 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

2.8 LOOSE STEEL LINTELS

- A. Fabricate loose structural steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Weld adjoining members together to form a single unit where indicated.
- C. Galvanize loose steel lintels located in exterior walls.

2.9 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.
- B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
 - a. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

2.11 ACCORDION SECURITY DOORS

- A. Accordion Security Doors shall be equal to No. 761S recessed cabinet doors by Acorn Wire & Iron Works, Inc. Standard factory painted finish in color as selected
- B. Supply hinged doors with manufacturer's standard lock with a cylinder that will accept Owner-installed Best core.
- C. Doors shall be 7'-0" high.

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2.12 FINISHES, GENERAL

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designing finishes.
- B. Finish metal fabrications after assembly.

2.13 STEEL AND IRON FINISHES

- A. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:
 - 1. ASTM A 153 for galvanizing iron and steel hardware.
 - 2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick or thicker.
- B. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6 "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3 "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.
- B. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

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3.2 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

3.3 SETTING LOOSE PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose leveling and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 - 1. Use nonshrink, metallic grout in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.

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3.4 ADJUSTING AND CLEANING

- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a 2.0-mil minimum dry film thickness.
- C. For galvanized surfaces, clean welds, bolted connections, and abraded areas, and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 05 50 00

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SECTION 05 51 00 - METAL STAIRS AND PIPE RAILING

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:
 - 1. Straight run, steel-framed stairs.
 - 2. Steel pipe handrails and railing systems attached to metal stairs.
 - 3. Steel pipe handrails attached to walls adjacent to metal stairs and ramps.
 - 4. Exterior balcony and associated steel pipe railings and guards.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Engineer, fabricate, and install steel stairs to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component of steel stairs.
 - 1. Treads of Steel Stairs: Capable of withstanding a uniform load of 100 lbf per sq. ft. or a concentrated load of 300 lbf on a area of 4 sq. inches located in the center of the tread, whichever produces the greater stress. Limit deflection to L/240 or ¼ inch, whichever is less, for total load and L/360 for live load only.
 - 2. Platforms of Steel Stairs: Capable of withstanding a uniform load of 100 lbf per sq. ft. Limit deflection to L/240 for total load and L/360 for live load only.
 - 3. Stair Framing: Capable of withstanding stresses resulting from loads specified above as well as stresses resulting from railing system loads.
- B. Structural Performance of Handrails and Railing Systems: Engineer, fabricate, and install handrails and railing systems to comply with requirements of ASTM E 985 for structural performance.
- C. Structural Performance: Engineer, fabricate, and install handrails and railing systems to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to

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produce the maximum stress in each of the respective components of each metal fabrication.

1. Top Rail of Guardrail Systems: Capable of withstanding the following loads applied as indicated:
 - a. Concentrated load of 200 lbf applied at any point and in any direction.
 - b. Uniform load of 50 lbf per linear foot applied horizontally and concurrently with uniform load of 100 lbf per linear foot applied vertically downward.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.
2. Handrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:
 - a. Concentrated load of 200 lbf applied at any point and in any direction.
 - b. Uniform load of 50 lbf per linear foot applied in any direction.
3. Infill Area of Guardrail Systems: Capable of withstanding a horizontal concentrated load of 200 lbf applied to one sq. ft. at any point in the system including panels, intermediate rails, balusters, or other elements composing the infill area.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Shop drawings detailing fabrication and installation of steel stairs, guards and railings. Include plans, elevations, sections, and details of steel stairs and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in producing steel stairs similar to those indicated for this Project with a record of successful in-service performance and with sufficient production capacity to produce required units without delaying the Work.
- B. Installer Qualifications: Arrange for steel stair installation specified in this Section by the same firm that fabricated them.

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PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Metal Surfaces, General: For surfaces exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, roughness, or, for steel sheet, variations in flatness exceeding those permitted by referenced standards for stretcher-leveled sheet. |
- B. Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).
- C. Steel Tubing: Product type (manufacturing method) and as follows:
 - 1. Cold-Formed Steel Tubing: ASTM A 500.
 - 2. Hot-Formed Steel Tubing: ASTM A 501. |
- D. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or another weight required by structural loads.
 - 1. Provide hot-dipped galvanized pipe for exterior guards and railings.
- E. Uncoated Steel Sheet: Commercial quality, product type (method of manufacture) as follows:
 - 1. Hot-Rolled Steel Sheet: ASTM A 569 (ASTM A 569M).

2.2 PAINT |

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

2.3 CONCRETE FILL AND REINFORCING MATERIALS |

- A. Concrete Materials and Properties: Comply with requirements of Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with a minimum 28-day compressive strength of 2,500 psi, unless higher strengths indicated. |

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2.4 FABRICATION, GENERAL

- A. Form steel stairs from materials of size, thickness, and shapes indicated, but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Shear and punch metals cleanly and accurately.
- D. Remove sharp or rough areas on exposed surfaces.
- E. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and welded surface matches contours of adjoining surfaces.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- H. Shop Assembly: Preassemble in shop to greatest extent possible to minimize field splicing and assembly. Use connections that maintain structural value of joined pieces. Clearly mark units for field assembly and coordinated installation.
- I. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.5 STEEL-FRAMED STAIRS |

- A. General: Construct stairs to conform to sizes and arrangements indicated. Join pieces together by welding, unless otherwise indicated. Provide complete stair assemblies, including metal framing, hangers, columns, handrails, railing systems, newels, balusters, struts, clips, brackets, bearing plates, or other components necessary for the support of

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stairs and platforms, and as required to anchor and contain the stairs on the supporting structure.

1. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM "Metal Stair Manual" for class of stair designated, except where more stringent requirements are indicated.

a. Commercial class, unless otherwise indicated.

B. Stair Framing: Fabricate stringers of structural steel channels, plates, or a combination thereof, as indicated. Provide closures for exposed ends of stringers. Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; and bolt or weld newels and framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finish surfaces.

1. Where masonry walls support steel stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Pan Risers, Subtreads, and Subplatforms: Shape metal pans for risers and subtreads to conform to configuration shown. Provide thicknesses of structural steel sheet for metal pans indicated, but not less than that required, to support total design loading.

1. Form metal pans of uncoated cold-rolled steel sheet, unless otherwise indicated.

2. Directly weld risers and subtreads to stringers; locate welds on side of metal pans to be concealed by concrete fill.

3. Shape metal pans to include nosing integral with riser.

4. Provide subplatforms of configuration and construction indicated; if not indicated, of same metal as risers and subtreads, in thicknesses required to support design loading. Attach subplatform to platform framing members with welds.

a. Smooth Soffit Construction: Construct subplatforms with smooth soffits.

2.6 STEEL PIPE HANDRAILS AND RAILING SYSTEMS

A. General: Fabricate pipe handrails and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.

B. Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

1. At tee and cross intersections, cope ends of intersecting members to fit contour of pipe to which end is joined, and weld all around.

C. Form changes in direction of handrails and rails as follows:

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1. As detailed.
2. By welding in prefabricated flush elbow fittings.
3. By radius bends of radius indicated.
4. By flush radius bends.
5. By bending.
6. By any method indicated above, applicable to change of direction involved. |

- D. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.
- E. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
- F. Close exposed ends of pipe by welding 3/16-inch- thick steel plate in place or with prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch or less.
- G. Fabricate newels of steel tubing and provide newel caps of gray-iron castings, as shown.
- H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of handrails and railing systems to other work. Furnish inserts and other anchorage devices for connecting handrails and railing systems to concrete or masonry work.
1. Connect railing posts to stair framing by direct welding, unless otherwise indicated.
- I. Fillers: Provide steel sheet or plate fillers of thickness and size indicated or required to support structural loads of handrails where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses. Size fillers to produce adequate bearing to prevent bracket rotation and overstressing of substrate. |

2.7 FINISHES

- A. General: Finish metal stairs after assembly.
1. Comply with NAAMM "Metal Finishes Manual" for recommendations on application and designations of finishes.
- B. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed units: |
1. Exteriors (SSPC Zone 1B): SSPC SP 6 "Commercial Blast Cleaning."

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2. Interiors (SSPC Zone 1A): SSPC SP 3 "Power Tool Cleaning."

- C. Apply shop primer to uncoated surfaces, except those with galvanized finish or those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, weld plates, and anchor bolts. Coordinate delivery of such items to Project site.

3.2 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing steel stairs to in-place construction; include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing steel stairs. Set units accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted field connections.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

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3.3 INSTALLING STEEL PIPE RAILINGS AND HANDRAILS

- A. Adjust handrails and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
 - 1. Anchor posts to steel by welding directly to steel supporting members.
 - 2. Anchor handrail ends into concrete and masonry with steel round flanges welded to rail ends and anchored into wall construction with drilled-in expansion anchors.

- B. Secure handrails to wall with wall brackets and end fittings. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets and wall return fittings to building construction as follows:
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. For concrete and solid masonry anchorage, use drilled-in expansion anchor.
 - 3. For hollow masonry anchorage, use toggle bolts having square heads.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on steel stairs are specified in Division 9 Section "Painting."

- B. For galvanized surfaces, clean welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 05 51 00

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SECTION 06 10 00 - ROUGH & FINISH CARPENTRY

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Wood blocking, furring, grounds and nailers.
 - 2. Roof sheathing and finished ceilings.
 - 3. Miscellaneous finish carpentry.

- B. Related Sections include the following:
 - 1. Division 6 Section “Interior Architectural Woodwork”.
 - 2. Division 6 Section “Metal Plate Connected Wood Trusses”.

1.2 SECTION REQUIREMENTS

- A. Submittals: Model code evaluation reports for engineered wood products.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

- A. Dressed lumber, S4S, 19 percent maximum moisture content for 2-inch (38-mm) thickness or less, marked with grade stamp of inspection agency.

2.2 TREATED MATERIALS

- A. Preservative-Treated Materials: AWPA C2 lumber and AWPA C9 plywood, labeled by an inspection agency approved by ALSC's Board of Review. After treatment, kiln-dry lumber and plywood to 19 and 15 percent moisture content, respectively. Treat indicated items and the following:
 - 1. Concealed members in contact with masonry or concrete.
 - 2. Wood truss plates installed on concrete masonry.

2.3 LUMBER

- A. Dimension Lumber: The following grades per inspection agency indicated.

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- B. Framing Lumber and Concealed Boards: 19 percent maximum moisture content: Mixed southern pine: No. 2 per SPIB rules or Western woods: Standard per WCLIB rules or No. 3 Common per WWPA rules.
- C. Miscellaneous Lumber: No. 3 or Standard grade of any species for nailers, blocking, and similar members.

2.4 ENGINEERED WOOD PRODUCTS

- A. Engineered wood products acceptable to authorities having jurisdiction and with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be demonstrated by comprehensive testing.
- B. Laminated-Veneer Lumber: Laminated with an exterior-type adhesive complying with ASTM D 2559, with grain of veneers parallel to their lengths.
 - 1. Extreme Fiber Stress in Bending: 2500 psi (17 MPa) for 12-inch nominal- (286-mm actual) depth members.
 - 2. Modulus of Elasticity: 2,000,000 psi (13 800 MPa).
- C. Parallel-Strand Lumber: Laid up from wood strands with exterior-type adhesive complying with ASTM D with grain of strands parallel to their lengths.
 - 1. Extreme Fiber Stress in Bending: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
 - 2. Modulus of Elasticity: 2,000,000 psi (13 800 MPa).

2.5 PANEL PRODUCTS

- A. Wood-Based Structural-Use Panels: DOC PS 2. Provide plywood complying with DOC PS 1, where plywood is indicated.
 - 1. Factory mark panels evidencing compliance with grade requirements.
 - 2. Panels with span ratings required by support spacing indicated.
 - 3. Roof Sheathing: APA-rated Structural I sheathing, B-C EXT, thickness as shown on plans.
 - 4. Ceiling Panels: APA-rated panels, 303-6-W or 303-6-S, 1/2" thickness. Southern Pine or Douglas Fir with a flame spread rating of 100-150.

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2.6 MISCELLANEOUS PRODUCTS

- A. Fasteners: Size and type indicated. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.
 - 1. Power-Driven Fasteners: CABO NER-272.
 - 2. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- B. Metal Framing Anchors: Hot-dip galvanized steel of structural capacity, type, and size indicated.
 - a. Adhesives for Field Gluing Panels to Framing: APA AFG-01.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fit rough carpentry to other construction; scribe and cope for accurate fit. Correlate location of furring, blocking, and similar supports to allow attachment of other construction.
- B. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Published requirements of metal framing anchor manufacturer.
 - 2. Table 1705.1--Fastening Schedule" of the Standard Building Code or Table 23-I-Q--Nailing Schedule" of the Uniform Building Code.
- C. Installation of Structural-Use Panels: Comply with applicable recommendations contained in APA Form No. E30 and as follows:
 - 1. Combination Subflooring-Underlayment: Glue and nail to framing.
 - 2. Sheathing: Screw or nail to framing.

END OF SECTION 06 10 00

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SECTION 06 17 00 - METAL-PLATE-CONNECTED WOOD TRUSSES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Structural Performance: Engineer, fabricate, and erect metal-plate-connected wood trusses to withstand design loads without exceeding deflection limits of ANSI/TPI 1, "National Design Standard for Metal-Plate-Connected Wood Truss Construction."
- B. Submittals: Product Data, Shop Drawings, and structural analysis data signed and sealed by a qualified professional engineer registered in the state where the Project is located.
- C. Engage a fabricator who participates in a recognized quality-assurance program that involves inspection by an independent inspecting and testing agency acceptable to authorities having jurisdiction.
- D. Comply with ANSI/TPI 1; TPI HIB, "Commentary and Recommendations for Handling Installing & Bracing Metal Plate Connected Wood Trusses"; and AFPA's "National Design Specification for Wood Construction" and its "Supplement."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Dimension Lumber: Comply with DOC PS 20, "American Softwood Lumber Standard," any species, graded visually or mechanically.
- B. Connector Plates: Structural-quality steel sheet, zinc coated, complying with ASTM A 653, Grade 33, G60 coating designation; at least 0.0359 inch thick.
- C. Fasteners: Hot-dip galvanized per ASTM A 153 or stainless steel, Type 304 or 316, where exposed to weather or to high relative humidities. Size and type indicated.
- D. Metal Framing Anchors: Manufactured from hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

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2.2 FABRICATION

- A. Fabricate wood trusses within manufacturing tolerances of ANSI/TPI 1 and connect truss members by metal connector plates.

2.3 DESIGN CRITERIA

- A. Design Criteria are as follows:
 - 1. Roof Live (snow) Load 30 PSF (plus drift)
 - 2. Live Load – Bottom chord 0 PSF
 - 3. Dead Load – Top chord 10 PSF plus
 - 4. Dead Load Bottom Chord 10 PSF
 - 5. Dead Load Trusses & Bracing Per Manufacturer
 - 6. Wind Load: per 2015 International Building Code
 - Basic Wind Speed 90 MPH (Vs3)
 - Exposure Category B
 - Importance Factor 1.0

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and brace trusses according to recommendations of TPI. Space trusses as indicated; install plumb, square, and true to line; and securely fasten to supporting construction.
- B. Anchor trusses securely at all bearing points using metal framing anchors and fasten securely.
- C. Securely connect each truss ply required for forming built-up girder trusses. Anchor trusses to girder trusses.
- D. Install and fasten permanent bracing during truss erection. Anchor ends of permanent bracing where terminating at walls or beams.
- E. Install wood trusses within installation tolerances of ANSI/TPI 1.
- F. Do not alter, cut, or remove truss members.
- G. Remove and replace wood trusses that are damaged or deficient.

END OF SECTION 06 17 00

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SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK

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:
 - 1. Plastic-laminate countertops and cabinets.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 6 Section "Rough & Finish Carpentry."

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each type of product and process specified and incorporated into items of architectural woodwork during fabrication, finishing, and installation.
- C. Shop drawings showing location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
- D. Samples for initial selection of the following in the form of manufacturer's color charts consisting of actual units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.
 - 1. Plastic laminates.
 - 2. Edge moldings.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units without delaying the Work.
- B. Installer Qualifications: Arrange for interior architectural woodwork installation by a firm that can demonstrate successful experience in installing architectural woodwork items similar in type and quality to those required for this Project.
- C. Quality Standard: Except as otherwise indicated, comply with the following standard:

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1. AWI Quality Standard: "Architectural Woodwork Quality Standards" of the Architectural Woodwork Institute for grades of interior architectural woodwork, construction, finishes, and other requirements.
2. The Contract Documents contain selections chosen from options in the Quality Standard as well as additional requirements beyond those of the Quality Standard. Comply with such selections and requirements in addition to the Quality Standard.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soilage, and deterioration.
- B. Do not deliver woodwork until painting and similar operations that could damage, soil, or deteriorate woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in "Project Conditions."

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet-work is completed, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to be fitted to other construction, check actual dimensions of other construction by accurate field measurements before fabrication, and show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Verify locations of concealed framing, blocking, reinforcements, and furring that support woodwork by accurate field measurements before being enclosed. Record measurements on final shop drawings.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2) - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade indicated and, where the following products

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are part of interior woodwork, with requirements of the referenced product standards that apply to product characteristics indicated:

1. Hardboard: AHA A135.4.
2. Medium-Density Fiberboard: ANSI A208.2.
3. Particleboard: ANSI A208.1, Grade M-2.
4. Softwood Plywood: PS 1.

B. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.

1. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
 - a. Formica Corporation.
 - b. Nevamar Corp.
 - c. Ralph Wilson Plastics Co.

2.2 INSTALLATION MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- B. Screws: Select material, type, size, and finish required for each use. Comply with ASME B18.6.1 for applicable requirements.
- C. Nails: Select material, type, size, and finish required for each use. Comply with FS FF-N-105 for applicable requirements.
- D. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed steel or lead expansion bolt devices for drilled-in-place anchors.

2.3 FABRICATION, GENERAL

- A. Fabricate woodwork to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly, finishing, and hardware application, before shipment to Project site to maximum extent possible. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

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2.4 COUNTERTOPS AND SPLASHES

- A. High-pressure decorative laminate counters and splashes: AWI “Custom” grade.
 - 1. Grade: HGS.
 - 2. Colors, Patterns, and Finishes: Provide Architect's selections from manufacturer's full range of colors and finishes.
 - 3. Edge Treatment: Same as laminate cladding on horizontal surfaces.
 - 4. Core Material: Exterior-grade plywood or medium-density particleboard.

2.5 CABINETS

- A. Laminate-Clad Cabinets (Plastic-Covered Casework): AWI “Custom” grade.
 - 1. AWI Type of Cabinet Construction: Flush overlay.
 - 2. Laminate Cladding:
 - a. Horizontal surfaces other than tops, HGS; postformed surfaces, HGP.
 - b. Vertical surfaces, HGS.
 - c. Edges, same as laminate cladding on horizontal surfaces.
 - d. Semi-exposed surfaces, VGS.
 - 3. Drawer Sides and Backs: Thermoset decorative overlay.
 - 4. Drawer Bottoms: Thermoset decorative overlay.

2.6 CABINET HARDWARE AND ACCESSORY SCHEDULE

- A. Concealed (European-Type) Hinges: B01602.
- B. Pulls: Wire pulls, 4 inches (100 mm) long, 5/16 inches (8 mm) in diameter.
- C. Catches: Friction catches, B03033.
- D. Adjustable Shelf Standards: B04071; with shelf rests, B04081.
- E. Drawer and Door Locks: E07121.
- F. Drawer Slides: Side-mounted, self-closing, zinc-plated steel drawer slides with steel ball bearings, complying with GHMA A156.9, Grade 1 and rated for the following loads:
 - 1. Box Drawer Slides: 100 lbf (440 N). Full extension.

PART 3) - EXECUTION

3.1 PREPARATION

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- A. Condition woodwork to average prevailing humidity conditions in installation areas before installing.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including back priming and removal of packing.

3.2 INSTALLATION

- A. Quality Standard: Install woodwork to comply with AWI Section 1700 for the same grade specified in Part 2 of this Section for type of woodwork involved.
- B. Install woodwork plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 1/8 inch in 96 inches for plumb and level.
- C. Scribe and cut woodwork to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.
- D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork and matching final finish where transparent finish is indicated.
- E. Tops: Anchor securely to base units and other support systems as indicated. Caulk space between backsplash and wall with specified sealant.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork where possible to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

3.4 PROTECTION

- A. Protect the work and maintain conditions during construction to ensure that woodwork is without damage or deterioration at the time of Substantial Completion.

END OF SECTION 06 40 23

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SECTION 07 11 00 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes cold-applied, emulsified-asphalt damp proofing applied to the following surfaces:
 - 1. Exterior, below-grade surfaces of building foundation walls and concealed surfaces of concrete retaining walls.
- B. Related Sections include
 - 1. Division 7 Section "Self-Adhering Sheet Waterproofing" for waterproofing.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.
- B. Material Certificates: For each product, signed by manufacturers.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

1.4 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit asphalt dampproofing to be performed according to manufacturers' written instructions.
- B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cold-Applied, Emulsified-Asphalt Dampproofing:
 - a. Euclid Chemical Company (The).
 - b. Henry Company.
 - c. Koppers Industries, Inc.
 - d. Meadows, W. R., Inc.
 - e. Master Builders.
 - 2. Protection Course, Asphalt-Board Type: As recommended by dampproofing manufacturer.

2.2 BITUMINOUS DAMPPROOFING

- A. Odor Elimination: For interior and concealed-in-wall uses, provide dampproofing material warranted by manufacturer to be substantially odor free after drying for 24 hours under normal conditions.
- B. Cold-Applied, Emulsified-Asphalt Dampproofing:
 - 1. Trowel Coats: ASTM D 1227, Type II, Class 1.
 - 2. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.
 - 3. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

2.3 MISCELLANEOUS MATERIALS

- A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.
- B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
- C. Protection Course, Asphalt-Board Type: Premolded, 1/8-inch- (3-mm-) thick, multiply, semirigid board consisting of a mineral-stabilized asphalt core sandwiched between layers of asphalt-saturated felt, and faced on 1 side with polyethylene film.

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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Applicator present, for compliance with requirements for surface smoothness and other conditions affecting performance of work.
 - 1. Begin dampproofing application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
- B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.

3.3 APPLICATION, GENERAL

- A. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.
 - 1. Apply additional coats if recommended by manufacturer or required to achieve coverages indicated.
 - 2. Allow each coat of dampproofing to cure 24 hours before applying subsequent coats.
- B. Apply dampproofing to footings and foundation walls where opposite side of wall faces occupied space whether indicated or not.
 - 1. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches over outside face of footing.
 - 2. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 - 3. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat required for embedding fabric is in addition to other coats required.

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3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. On Masonry Foundations: Apply one brush or spray coats at not less than 1.5 gal./100 sq. ft.
- B. On Backs of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft.
- C. On Masonry Backup for CMU Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft.
- D. On Face of Sheathing: Apply one brush or spray coat at not less than 1 gal./100 sq. ft.

3.5 INSTALLATION OF PROTECTION COURSE

- A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing material manufacturer's written recommendations for attaching protection course. Support protection course with spot application of trowel-grade mastic where not otherwise indicated.

3.6 CLEANING

- A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION 07 11 00

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SECTION 07 13 00 - COMPOSITE SHEET WATERPROOFING

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:
 - 1. Below-grade wall waterproofing on building retaining walls and other areas as shown on plans.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 3 Section "Cast-in-Place Concrete" for concrete placement, curing, and finishing.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide waterproofing that prevents the passage of liquid water under hydrostatic pressure and complies with requirements as demonstrated by testing performed by an independent testing agency of manufacturer's current sheet membrane.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of waterproofing specified, including manufacturer's printed instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties.

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1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an Installer who has completed waterproofing similar to that indicated for this Project and who is acceptable to waterproofing manufacturer.
- B. Single-Source Responsibility: Obtain waterproofing materials from a single manufacturer regularly engaged in manufacturing waterproofing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product, date of manufacture, and directions for storage.
- B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Apply waterproofing within range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

PART 2) - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Rubberized-Asphalt Composite Sheet:
 - a. CCW MiraDRI 860; Carlisle Corporation, Carlisle Coatings & Waterproofing Inc.
 - b. Bituthene: GCP Applied Technologies
 - c. Mel-rol; Meadows: W.R. Meadows, Inc.
 - d. TREM proof 500 series; Tremco

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2.2 SELF-ADHERING COMPOSITE SHEET

- A. Rubberized-Asphalt Composite Sheet: 60-mil- thick self-adhering sheet consisting of 56 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner on adhesive side.
 - 1. Sheet Type: Manufacturer's standard composite sheet for use when ambient and substrate temperatures exceed 40 deg F.
 - 2. Physical Properties: Provide waterproofing complying with the following:
 - a. Tensile Strength: 250 psi minimum; ASTM D 412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
 - c. Pliability: No cracks when bent 180 degrees over a 1-inch mandrel at minus 25 deg F; ASTM D 146.
 - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
 - e. Puncture Resistance: 40 lbf minimum; ASTM E 154.
 - f. Hydrostatic-Head Resistance: 150 feet minimum; ASTM D 5385.
 - g. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.

2.3 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with waterproofing sheet membrane.
 - 1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.
- B. Primer: Liquid primer recommended by manufacturer of sheet waterproofing material for substrate.
- C. Sheet Flashing: Self-adhering, rubberized-asphalt composite sheet of same material, construction, and thickness as waterproofing sheet membrane.
- D. Patching Membrane: Low-viscosity, 2-component, asphalt-modified coating.
- E. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.
- F. Protection Course: As follows:
 - 1. Semi-rigid sheets of fiberglass or mineral-reinforced asphaltic core, pressure laminated between 2 asphalt-saturated fibrous liners, 1/8-inch thickness, or equivalent systems recommended by manufacturer to protect the waterproofing membrane and relieve hydrostatic pressure.

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PART 3) - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions under which waterproofing systems will be applied, with Installer present, for compliance with requirements. Do not proceed with installation until unsatisfactory conditions have been corrected.
 - 1. Do not proceed with installation until after minimum concrete curing period recommended by waterproofing manufacturer.
 - 2. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 3. Notify Architect in writing of anticipated problems using waterproofing over substrate.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate at both new construction and any existing walls to be repaired according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage affecting other construction.
- C. Remove grease, oil, form release agents, paints, and other penetrating contaminants from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prime areas of existing wall to be repaired with appropriate primer to assure compatibility and proper bond to substrate.
- F. Prepare, fill, prime, and treat joints and cracks in substrate. Remove dust and dirt from joints and cracks according to ASTM D 4258.
 - 1. Install membrane strip and center over construction and control joints and cracks exceeding a width of 1/16 inch.
- G. Inside Corners: Prepare, prime, and treat inside corners according to waterproofing manufacturer's written instructions.
 - 1. Install membrane strip centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:

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- a. At footing-to-wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.
 - b. At deck-to-wall intersections, extend liquid membrane or sheet membrane flashing onto deck waterproofing and to finished height of sheet flashing.
- H. Outside Corners: Prepare and treat outside corners according to waterproofing manufacturer's written instructions.
1. Install strip of membrane 12 inches wide, centered over corner.
- I Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to waterproofing manufacturer's written instructions.
1. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge and cover with sheet membrane strips.

3.3 SELF-ADHERING COMPOSITE SHEET APPLICATION

- A. Install self-adhering composite sheet according to waterproofing manufacturer's written instructions.
- B. Apply primer to substrate at required rate and allow to dry. Limit priming to areas that will be covered by waterproofing membrane in same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheet membrane over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
 1. When ambient and substrate temperatures range between 25 and 40 deg F, install composite sheet waterproofing only with Architect's permission.
- D. Apply continuous sheet membrane over membrane strips bridging each type of joint to dimensions indicated or required by manufacturer.
- E. Seal exposed edges of membrane terminations not concealed by metal counterflashings or ending in reglets with mastic or sealant.
- F. Install sheet membrane and auxiliary materials to tie in adjacent waterproofing.
- G. Repair tears, voids, and lapped seams in waterproofing not meeting requirements. Slit and flatten fishmouths and blisters. Patch with sheet membrane extending 6 inches (150 mm) beyond repaired areas in all directions.

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3.4 PROTECTION COURSE INSTALLATION

- A. Install protection course over waterproofing membrane using tape or adhesive according to manufacturer's written instructions and before commencing subsequent construction operations. Minimize exposure of membrane.
 - 1. Molded-sheet drainage panels may be used in lieu of protection course to vertical applications when approved by waterproofing manufacturer.

3.5 FIELD QUALITY CONTROL

- A. Correct deficiencies in or remove waterproofing that does not comply with requirements, repair substrates, reapply waterproofing, and repair sheet flashings.

3.6 PROTECTING AND CLEANING

- A. Protect waterproofing from damage and wear during application and remainder of construction period, according to manufacturer's written instructions.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 13 00

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SECTION 07 21 00 - BUILDING INSULATION

PART 1 – GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data for each type of insulation product specified.

PART 2 - PRODUCTS

2.1 INSULATION PRODUCTS

- A. Extruded Polystyrene Board Insulation: Rigid, cellular, polystyrene thermal insulation with closed cells and integral high-density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV; in manufacturer's standard lengths and widths:
 - 1. Perimeter insulation under slabs on grade: Dow Styrofoam or equal, 24' width x 2" thickness.
- B. Flexible Glass-Fiber Batt Insulation: ASTM C 739, Type IA; formaldehyde-free, unfaced; nominal density of 1.5 lb/cu. ft. Install above soffits and in stud cavities for sound control; thickness as shown on drawings.
- C. Attic Insulation: Cellulose Insulation: ASTM C 612; install in attic space within roof framing. Install by blown-in method. Provide R-40 insulation settled depth.
 - 1. Cellulose insulation shall be treated with boric acid to create permanent flame resistance. Critical Radiant Flux: greater than or equal to 0.12 watts/cm². Smoldering Combustion: less than or equal to 15%.
 - 2. The maximum density after long-term settling for blown-in insulation: 1.6 lbs./cuft.
 - 3. The average thermal resistance per inch: 3.8 (R-Value/in).
 - 4. Surface Burning Characteristics:
 - a. Flame Spread: 20
 - b. Smoke Developed: 0
- D. Alternate Attic Insulation: Fiberglass. Spray-in fiber glass insulation equal to “JM Spider Custom Insulation” by Johns Manville. Insulation shall be Formaldehyde-free and contain an EPA-registered mold and mildew inhibitor. Provide R-40 insulation settled depth.

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PART 3 - EXECUTION

1.2 INSTALLATION

- A. Install insulation in areas and in thicknesses indicated or required to produce R-values indicated. Cut and fit tightly around obstructions and fill voids with insulation.
- B. Install vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage. Lap seams a minimum of 12".
- C. Cellulose Insulation: Install insulation in attic and wall assemblies after all mechanical, plumbing and electrical and other utility installations have been completed.
 - 1. Blown-in Attic Insulation: For loose fill cellulose applications, air seal all penetrations through the ceiling including plumbing, wiring, seams between top plate and drywall and all other gaps or holes, with the appropriate air sealing materials. Chimney and flue penetrations shall be air sealed with metal flashing and high temperature silicone sealants and a non-combustible insulation dam installed of sufficient distance and height to meet the code clearance to combustibles requirements. Install loose fill cellulose insulation in accordance with the manufacturer's instructions to settled thickness to provide settled R-40 value.
- D. Fiberglass Insulation: Place fiberglass loose-fill insulation into attic space as shown on plans, by machine blowing to comply with ASTM C1015. Level horizontal applications to uniform thickness to provide settled R-40 value. Hold insulation back from air vents, flues and heat-generating appliances.

END OF SECTION 07 21 00

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SECTION 07 53 00 - SINGLE-PLY MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. The project consists of installing an Adhered 80-mil TPO (Thermoplastic Polyolefin) Roofing System with a 30-year watertight warranty. Warranty shall also extend to associates sheet metal work.

1.2 EXTENT OF WORK

A. Provide all labor, material, tools, equipment, and supervision necessary to complete the installation of the reinforced TPO (Thermoplastic Polyolefin) Adhered Roofing System including flashings and insulation as specified herein and as indicated on the drawings in accordance with the manufacturer's most current specifications and details.

B. The roofing contractor shall be fully knowledgeable of all requirements of the contract documents and shall make themselves aware of all job site conditions that will affect their work.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, unopened containers or wrappings with the manufacturer's name, brand name and installation instructions intact and legible. Deliver in sufficient quantity to permit work to continue without interruption.

B. Comply with the manufacturer's written instructions for proper material storage.

C. Insulation must be on pallets, off the ground and tightly covered with waterproof materials.

D. Any materials which are found to be damaged shall be removed and replaced at the applicator's expense.

1.4 WORK SEQUENCE

A. Schedule and execute work to prevent leaks and excessive traffic on completed roof sections. Care should be exercised to provide protection for the interior of the building and to ensure water does not flow beneath any completed sections of the membrane system.

1.5 SAFETY

A. The roofing contractor shall be responsible for all means and methods as they relate to safety and shall comply with all applicable local, state and federal requirements that are safety related. Safety shall be the responsibility of the roofing contractor. All related personnel shall be

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instructed daily to be mindful of the full time requirement to maintain a safe environment for the facility's occupants including staff, visitors, customers and the occurrence of the general public on or near the site.

1.6 SUBMITTALS

A. Product Data: For each type of roofing product specified. Include data substantiating that materials comply with requirements.

B. Submit a letter of certification from the manufacturer which certifies the roofing contractor is authorized to install the manufacturer's roofing system.

C. Shop Drawings: Include plans, sections, and details of the following:

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.

D. Samples for Verification: Of the following products:

1. 12-by-12-inch square of sheet roofing, including lap seam.
2. 12-by-12-inch square of roof insulation.

E. Maintenance Data: For roofing system to include in the maintenance manuals specified in Division 1.

F. Warranty: Sample copy of standard roofing system manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements.

1.8 WARRANTY

A. Provide manufacturer's 30-year "Golden Seal" Warranty covering entire roof system "Edge to Edge" including membrane, flashing, insulation, adhesives, sheet metal and other components for both labor and material with no dollar limitation. The maximum wind speed coverage shall be peak gusts of 70 mph measured at 10 meters above ground level. Certification is required with the product submittal indicating the manufacturer has reviewed and agreed to such wind coverage.

1. Warranty shall also cover leaks caused by accidental punctures: 16 man-hours per year.
2. Warranty shall also cover all sheet metal work related to the roof system.

B. Pro-rated System Warranties shall not be acceptable.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: This specification is based on the "Sure-Weld" TPO System by Carlisle Syn-Tec, Inc. Subject to compliance with requirements, manufacturers offering systems that may be incorporated into the Work include, but are not limited to, the following:

1. TPO Sheet:
 - a. Firestone Building Products Company Ultra Ply TPO system
 - b. Tremco TremPly Max system
 - c. Johns Manville Corp JM TPO Systems
 - d. GAF EverGuard TPO system

2.2 TPO SHEET

A. Roof System TPO-30 Sheet: Uniform, flexible sheet formed from a Thermoplastic Polyolefin membrane complying with ASTM D 4637, Type 1, of the following grade, class, thickness, backing, and exposed face color:

1. UL Class: A.
2. Thickness: 80 mils, nominal.
3. Reinforcing: Nonwoven polyester fabric.
4. Exposed Face Color: Gray.
5. Elongation: 250% minimum, per ASTM D-412.
6. Breaking Strength: 250 lbs. Per ASTM D-751 A.
7. Tear Strength: 55 lbs. minimum, per ASTM D-751 B.

2.3 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with TPO membrane roofing.

B. Sheet Flashing: 80-mil-thick reinforced TPO membrane.

C. Bonding Adhesive: Use manufacturer's foam adhesive for the insulation and fleece-backed membrane. Use the manufacturer's standard low-VOC bonding adhesive elsewhere.

D. Splice Adhesive and Cleaner: Single-component butyl splicing adhesive and solvent-based splice cleaner.

E. Splice Primer and Tape: Manufacturer's standard synthetic rubber polymer primer and 3-inch-wide minimum, butyl splice tape with release film.

F. Lap Sealant: Manufacturer's standard single-component sealant.

G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

H. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately 1 inch wide, roll formed and pre-punched.

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I. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions of FM 4470, designed for fastening sheet to substrate, and acceptable to roofing system manufacturer.

J. Miscellaneous Accessories: Provide seam tape, pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, and other accessories recommended by roofing system manufacturer for intended use.

K. Traffic Pads: Protective surfacing for roof traffic shall be roof manufacturer's standard TPO Walkway Pads installed per manufacturer's requirements.

2.4 INSULATION MATERIALS

A. General: Provide preformed roof insulation boards that comply with requirements, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Cover Board Insulation: Cover board shall be high density polyisocyanurate foam core bonded to a coated glass-fiber facer equal to Carlisle SecureShield HD, 109 psi compressive strength. Install with approved adhesive or fasteners. Thickness shall be ½". Install directly onto plywood roof deck.

2.3 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatible with sheet roofing material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements.

B. Verify that roof openings and penetrations are in place and set and braced and that roof drains are properly clamped into position.

C. Verify that wood nailers are in place and secured and match thicknesses of insulation required.

D. Do not proceed with installation until unsatisfactory conditions have been corrected.

E. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

F. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of the roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

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3.2 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system manufacturer's written instructions for installing roof insulation.
- C. Trim surface of insulation where necessary at roof perimeter so completed surface is flush and does not restrict flow of water.
- D. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- E. Attached Insulation: Install each layer of insulation and secure to deck using adhesive or fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type indicated.
- F. Fasten insulation according to the insulation and roofing system manufacturers' written instructions to meet specified wind-uplift requirements.

3.3 ADHERED SHEET INSTALLATION

- A. Install TPO sheet over area to receive roofing according to roofing system manufacturer's written instructions. Unroll sheet and allow to relax for a minimum of 30 minutes.
- B. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Apply bonding adhesive to substrate and underside of sheet at rate required by manufacturer and allow to partially dry. Do not apply bonding adhesive to splice area of sheet.
- D. Adhesively fasten sheet securely at terminations and perimeter of roofing.
- E. Apply roofing sheet with side laps shingled with slope of roof deck where possible.
- F. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing sheet in place with clamping ring.

3.4 SEAM INSTALLATION

- A. Hot air weld the TPO membrane seams in accordance with the manufacturer's hot air welding procedures.
- B. Repair tears, voids, and lapped seams in roofing that does not meet requirements.

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3.5 FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of flashing sheet at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing as recommended by manufacturer.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.6 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect. Notify Architect or Owner 48 hours in advance of the date and time of inspection.

3.7 PROTECTING AND CLEANING

- A. Install walkways at all locations as identified on the drawings. Hot air weld walkway pads to the membrane in accordance with the manufacturer's specifications.
- B. Protect membrane roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its condition in a written report to Architect.
- C. Correct deficiencies in or remove roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair sheet flashings to a condition free of damage and deterioration at the time of Substantial Completion and according to warranty requirements.

END OF SECTION 07 53 00

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SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

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 sheet metal flashing and trim in the following categories:
 - 1. Exposed trim and fasciae.
 - 2. Metal flashing and counterflashing..
 - 3. Reglets.
 - 4. Scuppers, gutters and downspouts.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 4 Sections for through-wall flashing and other integral masonry flashings specified as part of masonry work.
 - 2. Division 7 Section "Manufactured Roof Specialties".
 - 3. Division 7 Section "Joint Sealants" for elastomeric sealants.
 - 4. Division 7 Sections "TPO Membrane Roof" for flashing and roofing accessories installed integral with roofing membrane as part of roofing-system work.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
- C. Shop Drawings of each item specified showing layout, profiles, methods of joining, and anchorage details.
- D. Samples of sheet metal flashing, trim, and accessory items, for finish selection.

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1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experience Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.6 PROJECT CONDITIONS

- A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 METALS

- A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability of alloy and temper designated below:
 - 1. Mill-Finish Aluminum Sheet: ASTM B 209, 3003-H14, with a minimum thickness of 0.040 inch, unless otherwise indicated.

2.2 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.
- B. Asphalt Mastic: SSPC-Paint 12, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry film thickness per coat.
- C. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
- D. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealants."
- E. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.
- F. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.

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- G. Roofing Cement: ASTM D 4586, Type I, asbestos free, asphalt based.

2.3 FABRICATION, GENERAL

- A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
- B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Form exposed sheet metal Work without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
- D. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- E. Expansion Provisions: Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- F. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
- G. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
- H. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
- I. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
 - 1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.4 SHEET METAL FABRICATIONS

- A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.

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- B. Gutters with Girth up to 15 Inches: Fabricate from the following material:
 - 1. Aluminum: 0.0320 inch thick, with factory-applied 70% fluoropolymer coating.
- C. Downspouts: Fabricate from the following material:
 - 1. Aluminum: 0.0320 inch thick, with factory-applied 70% fluoropolymer coating.
- D. Scuppers: Fabricate from the following material:
 - 1. Aluminum: 0.0320 inch thick, with factory-applied 70% fluoropolymer coating.
- E. Exposed Trim, Gravel Stops, and Fasciae: Fabricate from the following material:
 - 1. Aluminum: 0.050 inch thick, with factory-applied 70% fluoropolymer coating.
- F. Counterflashing: Fabricate from the following material:
 - 1. Aluminum: 0.040 inch thick, with factory-applied 70% fluoropolymer coating.
- G. Flashing Receivers: Fabricate from the following material:
 - 1. Aluminum: 0.040 inch, with factory-applied 70% fluoropolymer coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.
- B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Roof-Edge Flashings: Secure metal flashings at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.

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- D. Expansion Provisions: Provide for thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- E. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.
- F. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- G. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
 - 1. Underlayment: Where installing stainless steel or aluminum directly on cementitious or wood substrates, install a slip sheet of red-rosin paper and a course of polyethylene underlayment.
 - 2. Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.
- H. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counterflashing joints a minimum of 2 inches and bed with sealant.
- I. Roof-Drainage System: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate roof-drain flashing installation with roof-drainage system installation. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation.

3.3 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
- B. Maintain conditions that ensure sheet metal flashing and trim work not damaged during construction until Substantial Completion.

END OF SECTION 07 62 00

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SECTION 07 63 00 - MANUFACTURED ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Prefinished coping.
 - 2. Prefabricated attic vents.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Flashing and Sheet Metal" for the following Work:
 - a. Metal flashing and counter flashing.
 - b. Scuppers, gutters, and downspouts.
 - c. Miscellaneous sheet metal accessories.
 - 2. Roofing accessories installed integral with roofing membrane are specified in roofing system Sections as roofing work.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including manufacturer's technical data, installation instructions and general recommendations for each product specified. Include data substantiating that materials and performance comply with requirements.
- C. Shop drawings indicating layout, joining, profiles, accessories, anchorages, flashing connections, and relationship to supporting structure and to adjoining roof and wall construction.

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- D. Samples for initial selection purposes in form of manufacturer's sample finishes showing full range of colors and textures available for those units with factory-applied color finishes.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of manufactured roof specialty from one source and by a single manufacturer.
- B. Industry Standards: Provide products which comply with applicable requirements of SMACNA "Architectural Sheet Metal Manual."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide coping products by one of the following:
 - 1. Formed-Aluminum Copings:
 - a. ABC Seamless, Inc.
 - b. Architectural Products Co.
 - c. ATAS International, Inc.
 - d. Cheney Flashing Company
 - e. Hickman: W.P. Hickman Co.
 - f. Merchant and Evans, Inc.
 - g. Metal-Era Inc.
 - h. MM Systems Corp.
 - i. Petersen Aluminum Corp.
 - j. Southern Aluminum Finishing Co.
- B. Attic Vents: Sheet aluminum attic vents equal to #PV-20-C02 by Active Ventilation Products, roofvents.com. 20" diameter opening with 2.18 sf net free vent area. Install on 24" x 24" x 8" high roof curbs.

2.2 METALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for use intended and finish indicated, and with not less than the strength and durability of alloy and temper designated below:

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1. Alloy 3003-H14, with a minimum thickness of 0.040 inch unless otherwise indicated, for aluminum sheet with mill finish.
 2. Alloy 5005-H14, with a minimum thickness of 0.050 inch for aluminum sheet with other than mill finish.
- B. Galvanized Steel Sheets: ASTM A 653, G90 (ASTM A 653M, Z275) coating designation; commercial quality; at least 0.034 inch thick, unless otherwise indicated.

2.3 MISCELLANEOUS ITEMS

- A. Exposed Fasteners: Stainless steel, non-magnetic, of type and size standard with manufacturer for product and application indicated. Match finish of exposed heads with material being fastened.
- B. Concealed Fasteners: Same metal as item fastened or other noncorrosive metal as recommended by manufacturer.
- C. Mastic Sealant: Polyisobutylene; non-hardening, nonskinning, nondrying, nonmigrating sealant.
- D. Foam Rubber Seal: Manufacturer's standard foam.
- E. Adhesives: Type recommended by manufacturer for substrate and project conditions, and formulated to withstand minimum 60 psf uplift force.

2.4 ALUMINUM COPING

- A. Interlocking Multi-Part Coping and Gravel Stop System: Manufacturer's standard system consisting of coping formed from aluminum sheet to profile and of thickness indicated, zinc-coated steel anchor plate or cleat located at coping joint, and formed gutter chair or gutter/splice plate or compression pad/gutter; with prefabricated inside and outside corners, miters welded before finishing; without exposed fasteners.
1. Thickness of Coping: 0.063 inch.
 2. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 - a. Color Klad; Vincent Metals.
 - b. Splice-Lock Coping Cover System; Cheney Flashing Co.
 - c. Permasnap Coping; W. P. Hickman Co.
 - d. Snap-Lok Coping; MM Systems Corp.

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2.5 FABRICATION

- A. General: Provide items designed and fabricated to fit applications indicated and to perform optimally with respect to weather resistance, water tightness, durability, strength, and uniform appearance.
- B. Expansion Provisions: Fabricate running lengths to allow controlled expansion not only for movement of metal components in relationship to one another but also to adjoining dissimilar materials, including flashing and roofing membrane materials, in a manner sufficient to prevent water leakage, deformation or damage.

2.6 FINISHES

- A. Factory-Applied Finish: 70% Kynar/Hylar fluoropolymer coating 1.0 mil total dry thickness. Color as selected by Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive work of this Section, with vapor retarders, roof insulation, roofing membrane, flashing, and wall construction; as required to ensure that each element of the work performs properly, and that combined elements are waterproof and weathertight. Anchor products included in this Section securely to structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.
- B. Isolation: Where metal surfaces of units are installed in contact with dissimilar metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation as recommended by aluminum producer.

3.2 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces in accordance with manufacturer's instructions. Touch-up damaged metal coatings.
- B. Protection: Provide protective measures as required to ensure that work of this Section will be without damage or deterioration at time of substantial completion.

END OF SECTION 07 63 00

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SECTION 07 72 00 - ROOF HATCHES AND SAFETY RAILINGS

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:
 - 1. Roof hatches.
 - 2. Non-penetrating Guard Rails
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 6 Section "Rough Carpentry" for roof deck and nailers.
 - 2. Division 7 Section "TPO Membrane Roofing" for roofing types and roofing accessories included as part of roofing Work.
 - 3. Division 7 Section "Manufactured Roof Specialties" for fascia, coping, gravel stops, and roof expansion joint covers.
 - 4. Division 7 Section "Flashing and Sheet Metal" for metal flashing, valleys, gutters, and downspouts.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified. Submit manufacturer's detailed technical product data, installation instructions and recommendations, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

1.4 QUALITY ASSURANCE

- A. Standards: Comply with the following:

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1. SMACNA "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap-flashing to coordinate with type of roofing indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Roof Hatches and Fire Vents:
 - a. Babcock-Davis Hatchways, Inc.
 - b. Bilco Co.
 - c. Milcor, Inc.
 - d. O'Keeffe's, Inc.

2.2 MATERIALS, GENERAL

- A. Aluminum Sheets: ASTM B 209 for Alclad alloy 3005H25 or alloy and temper required to suit forming operations with mill finish.
- B. Extruded Aluminum: ASTM B 221 alloy 6063-T52 or alloy and temper required to suit structural and finish requirements. Mill finish.
- C. Insulation: Manufacturer's standard rigid or semirigid glass-fiber board of thickness indicated.
- D. Wood Nailers: Softwood lumber, pressure treated with water-borne preservatives for above-ground use, complying with AWPA C2; not less than 1-1/2 inch thick.
- E. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.

2.3 ROOF HATCHES

- A. Standard of Quality: Bilco Type S roof hatch with matching curb-mounted Bil-Guard 2.0 Safety Rail in gray powder coat finish. Equivalent hatches and railings by other manufacturers will be accepted.

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- B. General: Fabricate units to withstand 40-lbf/sq. ft. external loading and 20-lbf/sq. ft. internal loading pressure. Frame with 9-inch high, integral-curb, double-wall construction with 1-1/2inch insulation, cant strips and cap flashing (roofing counterflashing), with welded or sealed mechanical corner joints. Provide double-wall cover (lid) construction with 1 inch insulation core. Provide gasketing and equip with corrosion-resistant or hot-dip galvanized hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.
- C. Type: Single-leaf personnel access.
 - 1. For Ladder Access: 2 feet 6 inches by 3 feet 0 inch.
- D. Material: Aluminum, sheets and extrusions.

2.3 ROOF SAFETY RAILING SYSTEMS

- A. Roof safety railing system shall be equal to KeeGuard Roof Edge Fall Protection System. Railing system shall be constructed of Schedule 40 galvanized pipe. Provide mounting bases, counterweights and all other components and accessories for a complete and full installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's instructions and recommendations. Coordinate hatch installation with installation of roof trusses and deck and other materials to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor hatch securely to supporting structural substrates, adequate to withstand lateral and thermal stresses, as well as inward and outward loading pressures.
- B. Isolation: Where metal surfaces of units are to be installed in contact with incompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.
- C. Operation: Test hatches for ease of operation. Clean and lubricate joints and hardware. Adjust for proper operation.
- D. Install safety rails in accordance with manufacturer's recommendations.

END OF SECTION 07 72 00

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SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide sealants at intersection of building components and at control joints.

1.02 SUBMITTALS

- A. Submit for approval samples, color charts, and product data.

1.03 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Acrylic Sealant: Use at interior joints subject to minimal movement: hollow metal frames, GWB-CMU intersections, etc. Acrylic sealant shall be approved equal to the following:
 - 1. Master Builders, Master Seal NP 520.
 - 2. Pecora, AC-20 acrylic latex.
 - 3. Tremco, acrylic latex 834.
- B. Silicone Sealant: Use at interior joints subject to water exposure: at ceramic and porcelain tile, toilet fixtures, in shower, etc. Silicone sealant shall be approved equal to the following:
 - 1. Dow Corning 790 Building Sealant.
 - 2. General Electric Silpruf Weatherproofing Sealant.
 - 3. Pecora, 864 Low Modulus Architectural Sealant.
- C. Non-Sag Polyurethane Sealant: Use at exterior locations: windows, doors, masonry control joints, etc. Sealant shall be approved equal to the following:

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1. Pecora Dynaflex one part polyurethane.
 2. Master Builders NP-1 one part polyurethane.
 3. Tremco Dymonic one part polyurethane.
- D. Exterior Concrete Walk and Plaza Sealant: Use at junction of balcony and building face. Approved equal to Pecora "Dynatred" two- part, cold applied, Shore A 40 plus elastomeric non-self-leveling polyurethane sealant.
- E. Backer Rod: As recommended by sealant manufacturer. Backer rods shall be of a type and material which will not adhere to the sealant material.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Examine substrate; report unsatisfactory conditions in writing. Beginning work means acceptance of substrates.
- B. Provide sealants in colors as selected from manufacturer's standards.
- C. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction and with uniform appearance. Coordinate with work of other sections. Clean and prime joints, and install bond breakers, backer rods and sealant as recommended by manufacturers.
- D. Depth shall equal width up to 2" wide; depth shall equal 1/2 width for joints over 2" wide.
- E. Cure and protect sealants as directed by manufacturers. Replace or restore damaged sealants. Clean adjacent surfaces to remove spillage.

END OF SECTION 07 92 00

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SECTION 08 11 00 - STEEL DOORS AND FRAMES

PART 1) - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes:
 - 1. Steel doors.
 - 2. Steel door frames.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 4 Section "Unit Masonry" for building anchors into and grouting frames in masonry construction.
 - 2. Division 8 Section "Flush Wood Doors" for hollow-core and solid-core wood doors installed in steel frames.
 - 3. Division 8 Section "Door Hardware" for door hardware and weatherstripping.
 - 4. Division 8 Section "Glazing" for glass in doors and sidelights.
 - 5. Division 9 Section "Painting" for field painting primed doors and frames.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles, and finishes.
- C. Shop Drawings showing fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

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- D. Door Schedule: Submit schedule of doors and frames using same reference numbers for details and openings as those on Contract Drawings.

1.4 QUALITY ASSURANCE

- A. Provide doors and frames complying with ANSI/SDI 100 "Recommended Specifications for Standard Steel Doors and Frames" and as specified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
- B. Inspect doors and frames on delivery for damage. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect; otherwise, remove and replace damaged items as directed.
- C. Store doors and frames at building site under cover. Place units on minimum 4-inch- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to promote air circulation.

PART 2) - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Doors and Frames:
 - a. Amweld Building Products, Inc.
 - b. Benchmark Commercial Doors.
 - c. Ceco Door Products.
 - d. Curries Co.
 - e. Deansteel Manufacturing Co.
 - f. Fenestra Corp.
 - g. Kewanee Corp.
 - h. Mesker Door, Inc.

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- i. Pioneer Industries.
- j. Republic Builders Products.
- k. Steelcraft.

2.2 MATERIALS

- A. Hot-Rolled Steel Sheets and Strip: Commercial-quality carbon steel, pickled and oiled, complying with ASTM A 569 (ASTM A 569M).
- B. Cold-Rolled Steel Sheets: Carbon steel complying with ASTM A 366 (ASTM A 366M), commercial quality, or ASTM A 620 (ASTM A 620M), drawing quality, special killed.
- C. Galvanized Steel Sheets: Zinc-coated carbon steel complying with ASTM A 526 (ASTM A 526M), commercial quality, or ASTM A 642 (ASTM A 642M), drawing quality, hot-dip galvanized according to ASTM A 525, with A 60 or G 60 (ASTM A 525M, with Z 180 or ZF 180) coating designation, mill phosphatized.
- D. Supports and Anchors: Fabricated from not less than 0.0478-inch- thick steel sheet; 0.0516-inch- thick galvanized steel where used with galvanized steel frames.
- E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize complying with ASTM A 153, Class C or D as applicable.

2.3 DOORS

- A. Steel Doors: Provide 1-3/4-inch- thick doors of materials and ANSI/SDI 100 grades and models specified below, or as indicated on Drawings or schedules:
 - 1. Interior Doors: Grade II, heavy-duty, Model 1, full flush design, minimum 0.0478-inch- (1.2-mm-) thick cold-rolled steel sheet faces.
 - 2. Exterior Doors: Grade III, extra heavy-duty, Model 1, full flush design, minimum 0.0598-inch- (1.5-mm-) thick steel sheet faces.
- B. Vision Lite Systems: Manufacturer's standard kits consisting of glass lite moldings to accommodate glass thickness and size of vision lite indicated.

2.4 FRAMES

- A. Provide metal frames for doors, transoms, sidelights, borrowed lights, and other openings, according to ANSI/SDI 100, and of types and styles as shown on Drawings and schedules. Conceal fastenings, unless otherwise indicated. Fabricate frames of minimum 0.0598-inch- (1.5-mm-) thick cold-rolled steel sheet.

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1. Fabricate frames with mitered or coped and continuously welded corners.
 2. Fabricate frames for interior openings over 48 inches (1220 mm) wide from 0.0747-inch- (1.9-mm-) thick steel sheet.
 3. Fabricate exterior frames from 0.0785-inch- (2.0-mm-) thick galvanized steel sheet.
- B. Door Silencers: Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-door frames and 2 silencers on heads of double-door frames.
- C. Plaster Guards: Provide minimum 0.0179-inch- thick steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.
- D. Grout: When required in masonry construction, as specified in Division 4 Section "Unit Masonry."

2.5 FABRICATION

- A. Fabricate steel door and frame units to comply with ANSI A250.8 and be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
1. Internal Construction: One of the following manufacturer's standard core materials according to SDI standards:
 - a. Unitized steel grid for interior doors.
 - b. Vertical steel stiffeners with thermal insulation for exterior doors.
 2. Clearances: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between non-fire-rated pairs of doors. Not more than 3/4 inch at bottom. Clearances for fire-rated doors shall meet requirements of NFPA 80.
- B. Fabricate exposed faces of doors from only cold-rolled steel sheet.
- C. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet. Tops of doors shall be flush.
- E. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

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- F. Thermal-Rated (Insulating) Assemblies: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies and tested according to ASTM C 236 or ASTM C 976 on fully operable door assemblies.
- G. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.
- H. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.
- I. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.6.
- J. Glazing Stops: Minimum 0.0359-inch- (0.9-mm-) thick steel or 0.040-inch- (1-mm-) thick aluminum.
 - 1. Provide nonremovable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.
 - 2. Provide screw-applied, removable, glazing beads on inside of glass, louvers, and other panels in doors.

2.6 FINISHES, GENERAL

- A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.
- B. Apply primers and organic finishes to doors and frames after fabrication.

2.7 GALVANIZED STEEL SHEET FINISHES

- A. Surface Preparation: Clean surfaces with nonpetroleum solvent so that surfaces are free of oil or other contaminants. After cleaning, apply a conversion coating of the type suited to the organic coating applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
 - 1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.
- B. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply air-dried primer specified below immediately after cleaning and pretreatment.

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1. Shop Primer: Zinc-dust, zinc-oxide primer paint complying with performance requirements of FS TT-P-641, Type II.

2.8 STEEL SHEET FINISHES

- A. Surface Preparation: Solvent-clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel to comply with SSPC-SP 5 (White Metal Blast Cleaning) or SSPC-SP 8 (Pickling).
- B. Pretreatment: Immediately after surface preparation, apply a conversion coating of type suited to organic coating applied over it.
- C. Factory Priming for Field-Painted Finish: Apply shop primer that complies with ANSI A224.1 acceptance criteria, is compatible with finish paint systems indicated, and has capability to provide a sound foundation for field-applied topcoats. Apply primer immediately after surface preparation and pretreatment.

PART 3) - EXECUTION

3.1 INSTALLATION

- A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.
- B. Placing Frames: Comply with provisions of SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 1. Except for frames located in existing concrete, masonry, or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.
 2. In masonry construction, install at least 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.

3. At existing concrete or masonry construction, install at least 3 completed opening anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.
 4. In metal-stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In steel-stud partitions, attach wall anchors to studs with screws.
 5. Install fire-rated frames according to NFPA 80.
- C. Door Installation: Comply with ANSI A250.8. Fit doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.
1. Fire-Rated Doors: Install within clearances specified in NFPA 80.
 2. Smoke-Control Doors: Install to comply with NFPA 105.

3.2 ADJUSTING AND CLEANING

- A. Prime Coat Touchup: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
- B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION 08 11 00

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SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Samples for factory-finished doors.
- B. Quality Standard: NWWDA I.S.1-A.
- C. Door Manufacturer's Warranty: Submit written agreement on door manufacturer's standard form signed by Manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than ¼ inch in a 42-by-84-inch section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span, or do not conform to tolerance limitations of referenced quality standards.
 - 1. Warranty shall be in effect during the following period of time after date of Substantial Completion.
 - a. Solid Core Interior Doors: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide doors by one of the following:
 - 1. Solid Core Doors:
 - a. Algoma Hardwoods, Inc.
 - b. Eggers Industries, Architectural Door Division
 - c. Weyerhaeuser Co.

2.2 INTERIOR FLUSH WOOD DOORS

- A. Solid Core Doors: Comply with the following requirements:
 - 1. Faces: Select Red oak, plain sliced, complying with NEMA LD3 Grade HDS.
 - 2. Grade: Custom.
 - 3. Construction: 5 plies.
 - 4. Core: Particleboard core.
 - 5. Bonding: Stiles and rails bonded to core, then entire unit abrasive planed before veneering.

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2.3 LOUVERS AND LIGHT FRAMES

- A. Metals Louvers; Size, type and profile shown and fabricated from the following:
 - 1. Galvanized Steel: 0.0396 inch thick; hot dip, zinc coated, and factory primed for paint finish.
- B. Metal Frames for Light Openings in Fire Doors: Manufacturer's standard frame formed of 0.0478-inch thick cold-rolled steel sheet, factory primed, and approved for use in doors of fire-rating indicated.

2.4 FABRICATION AND FINISHING

- A. Factory fit doors to suit frame-opening sizes indicated and to comply with referenced quality standard.
- B. Factory machine doors for hardware that is not surface applied.
- C. Cut and trim openings to comply with referenced standards.
 - 1. Trim light openings with moldings indicated.
 - 2. Factory install louvers in prepared openings.
- D. Factory finish wood doors with NWWDA Select grade, System 3, conversion varnish or 5, catalyzed polyurethane.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install doors to comply with referenced quality standard.
 - 1. Install fire-rated doors to comply with NFPA 80.
- B. Align and fit doors in frames with uniform clearances and bevels. Machine doors for hardware. Seal cut surfaces after fitting and machining.
- C. Align factory-fitted doors in frames for uniform clearances.
- D. Repair, refinish, or replace factory-finished doors damaged during installation, as directed by Architect.

END OF SECTION 08 14 16

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SECTION 08 70 00 – DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Other doors to the extent indicated.
 - 2. Cylinders and/or cores for security gates specified in Section 05500.
- B. Related Sections include the following:
 - 1. Division 8 Section 08 11 13 "Hollow Metal Doors and Frames".
 - 2. Division 8 Section 08 14 16 "Flush Wood Doors".
 - 3. Division 26 "Electrical".
- C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
 - 1. Final replacement cores and keys to be installed by Owner.

1.2 REFERENCES

- A. Standards of the following as referenced:
 - 1. American National Standards Institute (ANSI)
 - 2. Door and Hardware Institute (DHI)
 - 3. Factory Mutual (FM)
 - 4. National Fire Protection Association (NFPA)
 - 5. Underwriters' Laboratories, Inc. (UL)
 - 6. Warnock Hersey (WHI)
 - 7. International Building Code (IBC)
- B. Regulatory Standards of the following as referenced:
 - 1. Department of Justice, Office of the Attorney General, *Americans with Disabilities Act*, Public Law 101-336 (ADA).

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2. COBO/ANSI A117.1: Providing Accessibility and Usability for Physically Handicap People, current edition.

1.3 SUBMITTALS

- A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Hardware Schedule to be furnished in 8-1/2" x 11".
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 - a. Organize door hardware sets in same order as in the Door Schedule.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item. If submitting products other than those specified, provide a complete cross-reference to products specified and products submitted.
 - c. Fastenings and other pertinent information.
 - d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Schedule each floor separately (i.e. schedule the entire first floor, then second floor, then third floor, etc.)
 - f. Explanation of abbreviations, symbols, and codes contained in schedule.
 - g. Mounting locations for door hardware.
 - h. Door and frame sizes and materials.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
 5. Submittal Sequence: Submit initial draft of final schedule along with essential

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Product Data to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit the final Door Hardware Schedule after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.

- C. Keying Schedule: Prepared by or under the supervision of supplier, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.
 - D. Product Certificates: Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.
 - 1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
 - E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
 - 1. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.
 - 2. Compliance to UBC 7-2 (1997) parts 1 & 2 and IBC (2000): Where compliance is required, provide door hardware which has positive pressure certification and "S" labels; UL10C classified Edge Sealing System and UL1784 Smoke & Draft Control Gasketing. Gasketing (including intumescent types as required) is to be provided as part of the door, frame and door hardware assembly.
 - a. Provide installation instructions, certificates for compliance and labels for UBC Standard 7-2 (1997) parts 1 & 2 and IBC (2000) Positive Pressure and "S". The certificate is to be used by the authority having jurisdiction for inspection.
 - F. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, indicating current products comply with requirements.
 - G. Maintenance Data: For each type of door hardware to include in maintenance manuals specified in Division 1.
 - H. Warranties: Special warranties specified in this Section.
- 1.4 QUALITY ASSURANCE
- A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

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- B. **Supplier Qualifications:** Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant (AHC), available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
- C. **Source Limitations:** Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.
- D. **Keying Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings." Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - 1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2. Preliminary key system schematic diagram.
 - 3. Requirements for key control system.
 - 4. Address for delivery of keys.

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 related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver keys to Owner in person.

1.6 COORDINATION

- A. **Templates:** Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.7 WARRANTY

- A. **General Warranty:** Special warranties specified in this Article shall not deprive Owner of

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other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of operators and door hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.
- D. Warranty Period for Exit Devices: Three years from date of Substantial Completion.
- E. Warranty Period for Manual Closers: Ten years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section, door hardware sets indicated in door and frame schedule, and the Door Hardware Schedule at the end of Part 3.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
 - 3. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Schedule at the end of Part 3.

2.2 HINGES

- A. Hinges:
 - 1. Acceptable manufacturers:
 - a. Hager Hinge Company
 - b. McKinney

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- c. Stanley Works
- 2. Characteristics:
 - a. Templates: Provide only template- produced units.
 - b. Screws: Provide Phillips flat-head screws complying with the following requirements:
 - 1) For metal doors and frames install machine screws into drilled and tapped holes.
 - 2) For wood doors and frames install threaded-to-the-head wood screws.
 - 3) For fire-rated wood doors install #12 x 13 inch, threaded-to-the-head steel wood screws.
 - 4) Finish screw heads to match surface of hinges or pivots.
 - c. Hinge pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1) Out-Swing Exterior Doors: Non-removable pins.
 - 2) Out-Swing Corridor Doors with Locks: Non-removable pins.
 - 3) Interior Doors: Non-rising pins.
 - 4) Tips: Flat button and matching plug. Finished to match leafs.
 - d. Size: Size hinges in accordance with specified manufacturer's published recommendations.
 - e. Quantity: Furnish one pair of hinges for all doors up to 5'0" high. Furnish one additional hinge for every 2½ feet or fraction thereof.
 - f. Clearances: Furnish wide throw hinge widths that positions the door out further, when open, than with a conventional hinge to clear applied trim on the frame or when doors are set in a deep reveal. Furnish raised barrel hinges for doors set in a deep reveal.
 - g. Materials: Provide non-ferrous hinges for use on all exterior doors and doors located in wet areas and in pool areas.

2.3 CYLINDERS AND KEYING

A. Cylinders:

- 1. Acceptable manufacturers:
 - a. Best Locking Systems
- 2. Characteristics:
 - a. All locks to be master keyed to the Roanoke City Public Schools master key system incorporating the interchangeable core.

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- b. All cores are to be of a seven pin design, and shall be instantly interchangeable without adaptation or modification into the core housings for mortise locks, rim locks, cylindrical locks, padlocks, letter file cabinet lock, cabinet door locks, storage cabinet handle locks, and any other types or applications included in the MASTER KEY system.
- c. The interchangeable core shall be removable with a control key which shall have an operating shear line for the control key involving all seven barrels. Such shear line shall be operable with the control key cuts different from the cost of the grandmaster key, in every barrel cut.
- d. The grandmaster, master, sub-master, and operating keys shall operate a shear line independent of the control shear line.
- e. The core shall have the capability of exposing single barrels for recombinations (i.e., each barrel shall be independently capped).
- f. All cores and keys shall be marked per owner specifications.
- g. All keyed cylinders shall be provided with Best Locking Systems construction cores for use by the Contractor during the construction period. Brass construction cores shall be used for all exterior doors. Plastic construction cores are permitted on the interior doors. After the building is accepted by the Owner, the owner shall remove the construction cores and install the master keyed cores. The Owner shall then return the construction cores to the Best Locking Systems. All construction cores and keys remain the property of Best Locking Systems. This construction core program shall be at no additional charge with proper return of construction cores.
- h. All locks shall be grandmaster keyed and master keyed to the specifications of the Owner. All permanent cores, together with all their keys, shall be shipped directly to the Owner only. The permanent cores are to be the same finish as specified for the locksets.
- i. Keys to be stamped "Do Not Duplicate".

2.4 LOCKSETS AND LATCHSETS

A. Acceptable manufacturers:

- 1. Best Lock Company
- 2. Schlage Lock Company
- 3. Falcon
- 4. Sargent

B. Characteristics:

- 1. Chassis: cylindrical design, corrosion-resistant plated cold-rolled steel.
- 2. Locking Spindle: stainless steel, interlocking design.
- 3. Latch Retractors: forged steel. Balance of inner parts: corrosion-resistant plated steel, or stainless steel.

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4. Lever Trim: accessible design, independent operation, spring-cage supported, minimum 2" clearance from lever mid-point to door face.
5. All locksets are to have the Lost Motion feature "LM" which allows the lever handle to move 45 degrees from parallel to the horizontal plane without engaging the latchbolt assembly when the lockset is in the locked mode. This feature makes over torque or over lever-age abuse more difficult to achieve.
6. Tactile warning: Tactile warning: provide tactile warning on doors that lead to areas that might prove dangerous to a person with a vision disability (*for example, doors to loading docks, platforms, boiler rooms, mechanical equipment rooms, electrical closets, stairs, stages and the like*). These doors shall be made identifiable to the touch by a textured surface on the door handle, lever, pull, or other operating hardware. The textured surface may be made by knurling or roughening or by a material applied to the surface.
7. Rosettes: minimum 3-7/16" diameter for coverage of ANSI/DHI A115.18, 1994 door preparation, through-bolt lugs on both spring cages to fully engage this pattern.
8. Springs: full compression type.
9. Strikes: 16 gage curved steel, bronze or brass with 1" deep box construction, lips of sufficient length to clear trim and protect clothing.
10. Lock Series and Design: Equal to Best 93K series, 15D design.

2.5 EXIT DEVICES

A. Acceptable manufacturers:

1. Von Duprin
2. Precision
3. Sargent

B. Characteristics:

1. Exit devices shall be "UL" listed for life safety. All exit devices for fire rated openings shall have "UL" labels for "Fire Exit Hardware."
2. All exit devices mounted on labeled wood doors shall be thru-bolted mounted on the door per the door manufacturers requirements.
3. All trim shall be thru-bolted to the lock stile case.
4. All exit devices shall be made of brass, bronze, stainless steel, or aluminum material, plated to the standard architectural finishes to match the balance of the door hardware. Painted or anodized aluminum finishes are not accepted.
5. Provide glass bead conversion kits to shim exit devices on doors with raised glass heads.
6. All exit devices trim to match the specified lock/latch trim.
7. All series exit devices shall incorporate a fluid damper, which decelerates the touchpad on its return stroke and eliminates noise associated with exit device operation. All exit devices shall be non-handed. Touchpad shall extend a minimum of 2 of the door width and shall be a minimum of 2 3/16" in height.

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Plastic touchpads are not acceptable. All latchbolts to be the deadlocking type. Latchbolts shall have a self-lubricating coating to reduce wear. Plated or plastic coated latchbolts are not acceptable.

8. Surface vertical rod devices shall be UL labeled for fire door (180- and 90-minute metal doors and 20-minute wood doors) applications without the use of bottom rod assemblies. Where bottom rods are required for security applications, the devices shall be US labeled for fire doors applications with rod and latch guards by the device manufacturer.

2.6 CLOSERS AND DOOR CONTROL DEVICES

A. Acceptable manufacturers:

1. LCN Closers
2. Sargent

B. Characteristics:

1. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder.
2. Hydraulic fluid shall be of a type requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F (49 degrees C) to -30 degrees F (-35 degrees C).
3. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed and back check.
4. All closers shall have solid forged steel main arms (and forearms for parallel arm closers) and where specified shall have a cast-in solid stop on the closer shoe ("cush"). Where door travel on out-swing doors must be limited, use "cush" type closers. Auxiliary stops are not required when cush type closers are used.
5. Access-Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped. provide adjustable units complying with ADA and ANSI A-117.1 provisions for door opening force.
6. Closers to be installed to allow door swing as shown on plans. Doors swinging into exit corridors shall provide for corridor clear width as required by code. Where possible, mount closers inside rooms.

2.7 OVERHEAD DOOR HOLDERS

A. Acceptable manufacturers:

1. Glynn Johnson
2. ABH
3. Rixson
4. Sarge

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B. Characteristics:

1. Provide heavy duty medium duty door holders concealed and surface mounted of stainless steel.
2. Concealed holders to be installed with the jamb bracket mortised flush with the bottom of the jamb. The arm and channel to be mortised into the door.
3. Surface holder to be installed with the jamb bracket mounted on the stop.

2.8 FLOOR STOPS AND WALL BUMPERS

A. Acceptable manufacturers:

1. Glynn Johnson
2. Ives
3. Rockwood Manufacturing

2.9 DOOR BOLTS AND COORDINATORS

A. Acceptable manufacturers:

1. Glynn Johnson
2. Ives
3. Rockwood Manufacturing

B. Characteristics:

1. Flush bolts to be forged brass 6-3/4" x 1", with 1/2" diameter bolts. Plunger to be supplied with milled surface one side which fits into a matching guide.
2. Automatic flush bolts to be UL listed as top and bottom bolts on a pair of classified fire doors. Bolt construction to be of rugged steel and brass components.
3. Coordinator to be soffit mounted non-handed fully automatic UL listed coordinating device for sequential closing of paired doors with or without astragals.
4. Provide filler pieced to close the header. Provide brackets as required for mounting of soffit applied hardware.

2.10 PROTECTION PLATES

A. Protective Plates:

1. Acceptable manufacturers:

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- a. Quality
 - b. Trimco
 - c. Rockwood Manufacturing
2. Characteristics:
- a. Provide manufacturers standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.
 - b. Materials:
 - 1) Metal Plates: Stainless Steel, .050 inch (U.S. 18 gage).
 - c. Fabricate protection plates 1½ inches less than full door width on stop side and 1 inch less than full door width on hinge side.
 - d. Heights:
 - 1) Kick plates to be 12 inches in height.
 - 2) Armor plates to be 30 inches in height.

2.11 THRESHOLDS AND WEATHERSTRIP

A. Thresholds:

1. Acceptable manufacturers:
 - a. National Guard Products, Inc.
 - b. Reese Industries
 - c. Zero Weatherstripping Co., Inc.

B. Weatherstripping:

1. Acceptable manufacturers:
 - a. National Guard Products, Inc.
 - b. Reese Industries
 - c. Zero Weatherstripping Co., Inc.

C. Gasketing

1. Acceptable manufacturers:
 - a. National Guard Products, Inc.
 - b. Reese Industries
 - c. Zero Weatherstripping Co., Inc.
2. Characteristics:
 - a. Gasketing that is to meet Category A positive pressure and “S” label requirements is to be integral intumescent supplied with the.
 - b. Gasketing that is to meet Category B positive pressure and “S” label requirements is to be self-adhesive intumescent fire and smoke seal.

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- 1) Self-adhesive silicone fire and smoke seal is acceptable if the approved door manufacturer has successfully passed testing for Category B with it.
- 2) As the door manufacturer and the gasketing manufacturer are tested as an assembly, the manufacturer of the self-adhesive fire and smoke seal gasketing (whether intumescent and/or silicone) is to be the one the approved door manufacturer has tested and been certified with.
- 3) Coordinate hinge backset requirements when using applied seals.

2.12 SILENCERS

A. Acceptable manufacturers:

1. Glynn Johnson
2. Ives
3. Rockwood Manufacturing

B. Three for each single door; two for each pair of doors.

2.13 MATERIALS AND FABRICATION

A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.

1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.

C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.

1. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

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2. Furnish screws for installation with each hardware item. Provide Philips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
3. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of adequately fastening the hardware. Coordinate with wood doors and metal doors and frames where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.
4. Final torque of all hardware fasteners shall be by hand and not by power tool.

2.14 HARDWARE FINISHES

- A. Match items to the manufacturer's standard color and texture finish for the latch and lock sets (or push-pull units if no latch or lock sets).
- B. Provide finishes that match those established by ANSI or, if none established, match the Architect's sample.
- C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- D. Provide protective lacquer coating on all exposed hardware finishes of brass, bronze, and aluminum, except as otherwise indicated. The suffix "-NL" is used with standard finish designations to indicate "no lacquer."
- E. The designations used to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

- | | | |
|----|-------------------------------|--|
| 1. | Hinges (Exterior) | 630 (US32D) Satin Stainless Steel |
| 2. | Hinges (Interior wood doors) | 652 (US26D) Satin Chrome Plated Steel |
| 3. | Hinges (Interior metal doors) | 600 (USP) Prime Coat Paint |
| 4. | Continuous Hinges | 628 (US28) Clear Anodized Aluminum |
| 5. | Flush Bolts | 626 (US26D) Satin Chrome Plated Brass/Bronze |
| 6. | Locks | 626 (US26D) Satin Chrome |
| 7. | Exit Devices | 626 (US26D) Satin Chrome |

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8.	Door Closers	689 (AL) Powder Coat
9.	Push Plates	630 (US32D) Satin Stainless Steel
10.	Pull Plates	630 (US32D) Satin Stainless Steel
11.	Protective Plates	630 (US32D) Satin Stainless Steel
12.	Door Stops - Floor	626 (US26D) Satin Chrome Plated Brass/Bronze
13.	Door Stops – Wall	630 (US32D) Satin Stainless Steel
14.	Overhead Holders	630 (US32D) Satin Stainless Steel
15.	Weatherstripping	628 (US28) Clear Anodized Aluminum
16.	Thresholds	627 (US27) Mill Aluminum

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.
- B. Wood Doors: Comply with DHI A115-W series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

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2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

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 work specified in Division 9 Sections. 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.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner will engage a qualified Independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 2. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- B. Six-Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:

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1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.6 CLEANING AND PROTECTION

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

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

END OF SECTION 08 70 00

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SECTION 08 81 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glazing materials installed as vision lights in non-rated doors.
- B. Related Sections include the following:
 - 1. Section "Steel Doors and Frames" for vision panels in doors.
 - 2. Section "Flush Wood Doors" for vision panels in doors.

1.2 SECTION REQUIREMENTS

- A. Submittals: Product Data and 12-inch-square Samples.
- B. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.
- C. Comply with written instructions of glass product manufacturers; GANA's "Glazing Manual;" and publications of GANA, AAMA, and SIGMA as applicable to products indicated, unless more stringent requirements are indicated.

PART 2 - PRODUCTS

2.1 GLASS

- A. Heat-Treated Float Glass: ASTM C 1048, Condition A (uncoated), Type I, Class 1 (clear) and Quality q3, Kind FT (fully tempered), where called for on drawings.
- B. Labeling: Permanently label each piece of tempered glazing material.

PART 3 - EXECUTION

1.1 INSTALLATION

- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are contained in GANA's "Glazing Manual."
- B. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

END OF SECTION 08 81 00

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SECTION 09 21 16 – GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior and exterior gypsum wallboard.
 - 2. Non-load-bearing steel framing.
- B. Related Sections include the following:
 - 1. Division 6 Section “Miscellaneous Carpentry” for blocking.

1.2 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.3 SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer’s written recommendations, whichever are more stringent.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Steel Framing and Furring:
 - a. Clark Steel Framing Systems.
 - b. Consolidated Systems, Inc.
 - c. Dale Industries, Inc. - Dale/Incor.
 - d. Dietrich Industries, Inc.
 - e. MarinoWare; Division of Ware Ind.
 - f. National Gypsum Company.
 2. Gypsum Board and Related Products:
 - a. American Gypsum Co.
 - b. G-P Gypsum Corp.
 - c. National Gypsum Company.
 - d. United States Gypsum Co.

2.2 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Components, General: Comply with ASTM C 754 for conditions indicated.
- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch diameter wire.
- C. Hangers: As follows:
1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
 2. Rod Hangers: ASTM A 510 (ASTM A 510M), mild carbon steel.
 - a. Diameter: 1/4-inch.
 - b. Protective Coating: Corrosion-resistant paint.
 3. Flat Hangers: Commercial-steel sheet, ASTM A 366/A 366M, with corrosion-resistant paint finish.
 - a. Size: 1 by 3/16 inch by length indicated.
 4. Angle Hangers: ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized commercial-steel sheet.

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- a. Minimum Base Metal Thickness: 0.0312 inch.
 - b. Size: 7/8 by 1-3/8 inches.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, a minimum 1/2-inch wide flange, with manufacturer's standard corrosion-resistant zinc coating.
- 1. Depth: 2 inches.
- E. Furring Channels (Furring Members): Commercial-steel sheet with manufacturer's standard corrosion-resistant zinc coating.
- 1. Cold Rolled Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch wide flange, 3/4 inch deep.
 - 2. Steel Studs: ASTM C 645.
 - a. Minimum Base Metal Thickness: 0.0179 inch.
 - b. Depth: As indicated.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base Metal Thickness: 0.0179 inch.

2.3 INTERIOR GYPSUM WALLBOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: ASTM C 36.
 - 1. "Paperless" Drywall: Glass-faced, mold resistant gypsum board. Use for all interior applications. Thickness as indicated.
 - 2. Fiberglass sheathed Drywall: Use at exterior soffits. Thickness as indicated.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape: Fiberglass.

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- C. Joint Compound for Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound or drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.
- B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet

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accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

3.3 INSTALLING STEEL SUSPENDED CEILING FRAMING

- A. Suspend ceiling hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 4. Secure rod, flat, or angle hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 5. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 6. Do not attach hangers to steel deck tabs.
 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.
- C. Sway-brace suspended steel framing for "clouds" with hangers used for support.
- D. Wire-tie furring channels to supports.
- E. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
1. Hangers: 48 inches o.c.
 2. Carrying Channels (Main Runners): 48 inches o.c.
 3. Furring Channels (Furring Members): 16 inches o.c.

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- F. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.4 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum 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.
- E. 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.
- F. Attach gypsum panels to framing provided at openings and cutouts.
- G. Form control and expansion joints with space between edges of adjoining gypsum panels.
- H. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 - 1. Space screws a maximum of 12 inches o.c. for vertical applications.

3.5 PANEL APPLICATION METHODS

- A. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
- B. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

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3.6 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.

3.7 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 - 2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile.
 - 3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges. Use Level 4 finish for areas of exposed work.

END OF SECTION 09 21 16

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SECTION 09 51 00 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and material Samples.
- B. Acoustical Panel Ceilings: ASTM E 1264, Class A materials, tested per ASTM E 84.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CEILING SYSTEMS

- A. Ceiling Panels: 24" x 24" x 5/8" tile, square edge, NRC .50-.60, Armstrong Ceramaguard Fine Fissured, Item No. 607, or USG Radar Education, Item. No. 2206.

2.2 CEILING SUSPENSION SYSTEM

- A. Exposed grid suspension system: Standard intermediate duty painted steel; T-grid. Use white color grid with lay-in tile.
 - 1. Use twisted pair stainless steel wire and/or suspension rods to suspend ceiling clouds.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials and suspension systems in accordance with manufacturer's instructions and recommendations, and ASTM C 636. Coordinate installation with location of mechanical and electrical work to ensure proper locations.
- B. Level ceiling to within 1/8" in 10' in both directions. Scribe and cut panels to fit accurately. Bevel edges of Type 1 panels and paint to match tile color.
- C. Adjust, clean, and touch-up system components.
- D. Provide wrapped and labeled maintenance stock of new material equal to 5 percent of ceiling panels, tile, and suspension installed.

END OF SECTION 09 51 00

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SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide resilient flooring and base.
- B. Extra Materials: Deliver to Owner at least 1 box for each 50 boxes or fraction thereof, of each type and color of resilient floor tile installed.

1.2 SUBMITTALS

- A. Submit for approval samples, product data, extra stock.

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer=s instructions.
- B. Provide materials and adhesives which do not contain asbestos.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Standard Vinyl Composition Tile: Provide 1/8" x 12" x 12" size; Armstrong Imperial Texture Excelon Tile. All tile in accordance with the requirements of Federal Specification SS-T-312B(1), Type IV, Comp. I and ASTM F 1066, Comp I.
 - 1. Colors will be selected from the full range currently available from Armstrong in thickness designated.
 - 2. Through-grained tile patterns shall have uniform dispersement of color and texture throughout the thickness of the tile.
 - 3. Equivalent products by Johnsonite or Tarkett will be accepted.
- B. Rubber Base: Provide 1/8" x 4" high, thick extruded rubber cove base as manufactured by Roppe Corporation or equal. The base shall conform fully to the requirements of Federal Specifications SS-W-40, Type I, Rubber.

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- C. Accessories: Provide rubber accessories equal to Roppe products listed below:
 - 1. VCT to Concrete: No. 48.
- D. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations. Install in proper relation to adjacent work.
- B. Prepare surfaces by cleaning, leveling and priming as required. Test adhesive for bond before general installation. Level to 1/8" in 10' tolerance.
- C. Repair chips, dents, etc. in slab with patching compound as required to provide smooth substrate for installation of tile.
- D. Lay standard 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 cut widths less than 3" at room perimeters. Lay tile square to room axis, unless otherwise shown.
- E. Install wall base in maximum lengths possible. Apply to walls, columns, pilasters, casework, and other permanent fixtures in rooms or areas where base is required.
 - 1. Job-Formed Corners: Form wall base corners from straight pieces of maximum lengths possible.
- F. Clean, polish, and protect.

END OF SECTION 09 65 00

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SECTION 09 67 23 – RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes resinous flooring systems.
 - 1. Application Method: Troweled or screeded.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
- B. Samples for Initial Selection: For each type of exposed finish required.
- C. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.
- D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- E. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.
 - 1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
- B. Source Limitations: Obtain primary resinous flooring materials, including primers, resin hardening agents, grouting coats, and topcoats, through one source from a single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

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- C. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Apply full-thickness mockups on 48-inch square floor area selected by Architect. Include 48-inch length of integral cove base.
 - 2. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
- B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
 - 1. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

- 1.6 Resinous Flooring: Where this designation is indicated, provide resinous flooring system complying with the following:
 - A. Products: Provide one of the following:
 - 1. Dex-O-Tex International, Ltd.; Décor Flor.
 - 2. Delta Polymers: Poly Tex.
 - 3. Stonehard, Inc.; Stonshield SLT.

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- B. Color and Pattern: As selected by Architect from manufacturer's full range of colors and patterns produced for resinous flooring complying with requirements indicated.
- C. System Thickness: 1/8 inch.
- D. Wearing Surface: Antislip.
- E. Components: Provide manufacturer's standard components complying with requirements, unless otherwise indicated. Provide the following optional components:
 - 1. Primer or undercoat.
 - 2. Aggregates: Colored quartz.
 - 3. Chemical-resistant sealing or finish coat(s).
- F. Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to standard test methods indicated:
 - 1. Compressive Strength: 9000 per ASTM C 579.
 - 2. Tensile Strength: 1600 per ASTM C 307.
 - 3. Flexural Modulus of Elasticity: 1.0×10^6 per ASTM C 580.
 - 4. Water Absorption: .01% per ASTM C 413.
 - 5. Indentation: .025 maximum per MIL-D-3134.
 - 6. Coefficient of Friction: .7-.9.
 - 7. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch permanent indentation per MIL-D-3134.
 - 8. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch per MIL-D-3134.
 - 9. Flammability: Self-extinguishing per ASTM D 635.
 - 10. Hardness: 85-90, Shore D per ASTM D 2240.
 - 11. Bond Strength: >400 psi, 100 percent concrete failure per ACI 503R.

2.2 ACCESSORY MATERIALS

- A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
- B. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated.

PART 2 - EXECUTION

3.1 PREPARATION

- A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate

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for resinous flooring application.

- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil and other contaminants incompatible with resinous flooring.
 - 1. Roughen concrete substrates as follows:
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and re-circulates the shot by vacuum pickup.
 - 2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.
 - 3. Verify that concrete substrates are dry.
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab in 24 hours.
 - b. Perform plastic sheet test, ASTM D 4263. Proceed with application only after test indicates absence of moisture in substrates.
 - c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.
 - 4. Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
- D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- E. Treat control joints and other non-moving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations.

3.2 APPLICATION

- A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - 1. Coordinate application of components to provide optimum adhesion of resinous

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flooring system to substrate, and optimum intercoat adhesion.

2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.
 - a. Apply joint sealant to comply with manufacturer's written recommendations.
- B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Apply reinforcing membrane to substrate cracks.
- D. Apply self-leveling slurry body coat(s) in thickness indicated for flooring system.
 1. Broadcast aggregates and, after resin is cured, remove excess aggregates to provide surface texture indicated.
- E. Apply troweled or screeded body coat(s) in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, sand to remove trowel marks and roughness.
- F. Apply grout coat, of type recommended by resinous flooring manufacturer to fill voids in surface of final body coat and to produce wearing surface indicated.
- G. Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.3 CLEANING AND PROTECTING

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 23

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SECTION 09 91 00 - PAINTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Summary: Paint all exposed surfaces, as listed in Finish Schedule.
- B. Submittals: Product Data and color Samples.
- C. Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

PART 2 - PRODUCTS

2.1 PAINT

- A. The Contractor shall utilize Benjamin Moore products for all interior and exterior painting and finishing work. No substitutions.
- B. Use the following products:
 - 1. Interior, non-epoxy paints: Ultra Spec 500 or Super Spec
 - 2. Interior Epoxy: Corotech Waterborne Acrylic Epoxy
 - 3. Exterior Masonry: ultra spec EXT
 - 4. Exterior Metal: Ultra Spec HP D.T.M. Acrylic Enamel
 - 5. Primers: As recommended for each finish paint by manufacturer

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

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3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Provide barrier coats over incompatible primers or remove and reprime.
 - 2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, by removing efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze.
 - 3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - 4. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
 - a. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
 - 5. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

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1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- E. Tinting: Tint primer coats to match the color of the finish coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 3. Provide finish coats that are compatible with primers used.
 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convactor covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 6. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 7. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 8. Sand lightly between each succeeding enamel or varnish coat.
 9. Omit primer on metal surfaces that have been shop primed and touchup painted.
 10. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
- B. Application Procedures: Apply paints and coatings by brush, roller, or other applicators according to manufacturer's written instructions.
- C. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- D. Previously painted surfaces scheduled to be painted: Paint as scheduled for new work, but deleting one primer or finish coat, as determined in field by Architect, or as otherwise specified.

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- E. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled. Apply two coats of filler in showers.
- F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- G. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- H. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
- I. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 EXTERIOR PAINT APPLICATION SCHEDULE

- A. Ferrous Metal: (Railings, structural steel) As follows:
 - 1. Low lustre, D.T.M. Acrylic Enamel: Two coats.
- B. Zinc-Coated Metal: (Hollow metal doors and frames) As follows:
 - 1. Low lustre, D.T.M. Acrylic Enamel: Two coats.
- C. Exterior Concrete Block: As follows:
 - 1. Low lustre, Acrylic Enamel: Two coats over block filler

3.5 INTERIOR PAINT APPLICATION SCHEDULE

- A. Concrete Planks: As follows
 - 1. Satin, Acrylic Enamel: Two coats over primer.
- B. Concrete Masonry Units (as shown on finish Schedule): As follows:
 - 1. Satin or Gloss, Acrylic Enamel: Two coats over block filler.
- C. Epoxy on CMU: (as shown on finish Schedule)
 - 1. Primer: Manufacturer's Recommended Epoxy Block Filler, 10-20 mils dft.
 - 2. Topcoats: Waterborne Acrylic Epoxy, 3.0 mils dft - 1 coat.

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- D. Gypsum Board and Plaster Walls, Partitions and Ceilings: As follows:
 - 1. Satin, Acrylic Enamel: Two coats over primer.
- E. Woodwork and Hardboard: (wood trim, plywood ceilings) As follows:
 - 1. Satin, Acrylic Enamel: Two coats over primer.
- F. Ferrous Metal: As follows:
 - 1. Satin, Acrylic Enamel (Hollow metal, structural steel, etc.): Two coats over primer.
- G. Zinc-Coated Metal: As follows:
 - 1. Satin, Acrylic Enamel: Two coats over galvanized metal primer.
- H. Epoxy on CMU: (as shown on finish Schedule)
 - 1. Primer: Cementitious Water Based Epoxy Block Filler, 10-20 mils dft.
 - 2. Topcoats: Water based Catalyzed Epoxy resin, 3.0 mils dft - 2 coats.

END OF SECTION 09 91 00

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SECTION 10 11 00 - VISUAL DISPLAY BOARDS

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:
 - 1. Porcelain enamel markerboards.
 - 2. Vinyl-fabric-faced cork tackboards.

1.3 SUBMITTALS

- A. Product Data: For each type of visual display board indicated.
- B. Shop Drawings: For each type of visual display board required.
 - 1. Include dimensioned elevations. Show location of joints between individual panels where unit dimensions exceed maximum panel length.
 - 2. Include sections of typical trim members.
 - 3. Show anchors, grounds, reinforcement for installation on steel stud walls, accessories, layout, and installation details.
- C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors and textures available.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Porcelain Enamel Markerboards:
 - a. AARCO Products, Inc.
 - b. Carolina Chalkboard Co.
 - c. Claridge Products and Equipment, Inc.
 - d. Greensteel, Inc.
 - e. Marsh Industries, Inc.
 - f. Nelson Adams Company
 - g. Polyvision Corporation

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2. Tackboards and Tackstrips:
 - a. Carolina Chalkboard Co.
 - b. Claridge Products and Equipment, Inc.
 - c. Greensteel, Inc.
 - d. Nelson Adams Company.
 - e. Polyvision Corporation

2.2 MATERIALS

- A. Porcelain Enamel Chalkboards and Markerboards: Balanced, high-pressure-laminated, porcelain enamel chalkboards of 3-ply construction consisting of face sheet, core material, and backing. The face sheet shall be one of the following:
 1. Face Sheet: 0.024-inch enameling grade steel especially processed for temperatures used in coating porcelain on steel. Coat exposed face and edges with a 3-coat process consisting of primer, ground coat, and color cover coat. Coat concealed face with a 2-coat process consisting of primer and ground coat. Fuse cover and ground coats to steel at manufacturer's standard firing temperatures, but not less than 1200 deg F.
 - (1) Face Sheet: 0.024-inch-, "Vitracite," porcelain enamel clad, Type 1, stretcher-leveled aluminized-steel face sheet, as manufactured by Claridge Products and Equipment. Fuse porcelain enamel coating to steel at approximately 1000 deg F.
 3. Face Sheet Cover Coat: Provide manufacturer's standard, light-colored, special writing surface with low gloss finish intended for use with erasable dry markers.
 4. Core: 3/8-inch- thick, particleboard core material complying with requirements of ANSI A208.1, Grade 1-M-1.
 5. Backing Sheet: 0.005-inch- thick, aluminum-foil sheet backing.
 6. Laminating Adhesive: Manufacturer's standard, moisture-resistant, thermoplastic-type adhesive.
 7. Size: Provide nominal 4'-0" high units by lengths shown on plans.
- B. Vinyl-Fabric-Faced Tackboards and Tackstrips: Mildew-resistant, washable vinyl fabric complying with FS CCC-W-408, Type II, weighing not less than 13 oz./sq. yd., laminated to 1/4-inch- thick cork sheet. Provide fabric with a flame-spread rating of 25 or less when tested according to ASTM E 84. Provide color and texture as scheduled or as selected from manufacturer's standards.
 1. Backing: Factory laminate cork face sheet under pressure to 1/4-inch- thick hardboard backing.
 2. Size: Provide nominal 4'-0" high units by lengths shown on plans.

2.3 ACCESSORIES

- A. Metal Trim and Accessories: Fabricate frames and trim of not less than 0.062-inch-thick, extruded-aluminum alloy, size and shape as indicated, to suit type of installation.

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Provide straight, single-length units. Keep joints to a minimum. Miter corners to a neat, hairline closure.

1. Field-Applied Trim: Manufacturer's standard slip-on trim.
2. Map Rail: Furnish map rail full width at top of each markerboard and tackboard unit, complete with the following accessories:
 - a. Display Rail: Provide continuous cork display rail approximately 1 inch wide integral with map rail.
 - b. End Stops: Provide one end stop at each end of map rail.

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2.4 FABRICATION

- A. Porcelain Enamel Markerboards: Laminate facing sheet and backing sheet to core material under pressure with manufacturer's recommended flexible, waterproof adhesive.
- B. Assembly: Provide factory-assembled markerboard and tackboard units, unless field-assembled units are required.

2.5 FINISHES

- A. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 607.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine wall surfaces, with Installer present, for compliance with requirements and other conditions affecting installation of visual display boards.
 - 1. Surfaces to receive markerboards shall be free of dirt, scaling paint, and projections or depressions that would affect smooth, finished surfaces of markerboards.
 - 2. Surfaces to receive tackboards shall be dry and free of substances that would impair the bond between tackboards and substrate.
 - 3. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units in locations and at mounting heights indicated and according to manufacturer's written instructions. Keep perimeter lines straight, plumb, and level. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

3.3 ADJUSTING AND CLEANING

- A. Clean units according to manufacturer's written instructions.

END OF SECTION 10 11 00

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SECTION 10 21 13 – TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes solid-polymer units as follows:
 - 1. Toilet Enclosures: Overhead braced and floor anchored.
 - 2. Urinal Screens: Wall hung, post supported and overhead braced.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Carpentry" for blocking.
 - 2. Division 10 "Toilet and Bath Accessories" for toilet tissue dispensers, grab bars, and similar accessories.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of reinforcements for compartment-mounted grab bars.
- C. Samples for Initial Selection: For each type of unit indicated.
- D. Samples for Verification: Of each type of color and finish required for units, prepared on 6-inch square Samples of same thickness and material indicated for Work.
- E. Fire-test-response characteristics.
- F. Warranties: Special warranties specified in this section.

1.3 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.

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1.4 WARRANTY

- A. Manufacturer's Special Warranty: Written warranty made out to Owner and signed by manufacturer guaranteeing its plastic against breakage, corrosion, and delamination under normal conditions. If materials are found to be defective during the warranty period for reasons listed above, the materials will be replaced free of charge.
 - 1. Warranty Period: 10 Years from date of substantial completion.

PART 2 - PRODUCTS

2.1 SOLID-POLYMER UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Accurate Partitions Corporation.
 - 2. Bradley Corporation; Mills Partitions.
 - 3. Bobrick Washroom Equipment.
 - 4. Capitol Partitions, Inc.
 - 5. Comtec Industries.
 - 6. General Partitions Mfg. Corp.
 - 7. Global Steel Products Corp.
 - 8. Santana Products, Inc.
 - 9. Partition Systems, Inc.
- B. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
 - 1. Color and Pattern: One color and pattern in each room as selected by Architect from manufacturer's full range of colors and patterns.
- C. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; Type 302 or 304 stainless steel, not less than 0.0312 inch thick and 3 inches high.
- D. Wall Brackets (Fittings): Full-Height (Continuous) Type, manufacturer's standard design; stainless steel or aluminum.
- E. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum strip fastened to exposed bottom edges of solid-polymer components to prevent burning.

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2.2 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
 - 1. Material: Stainless steel; No substitutions or other material types are permitted.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish. Provide along entire front and side returns. Provide end closure caps.
- C. Support Posts for Urinal Screens: Manufacturer's standard aluminum or stainless steel post with floor shoe for anchoring to floor construction.
- D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.3 FABRICATION

- A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.
- B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- C. Doors: Unless otherwise indicated, provide 24-inch wide in-swinging doors for standard toilet compartments and 36-inch wide out-swinging doors with a minimum 32-inch wide clear opening for compartments indicated to be accessible to people with disabilities.
 - 1. Hinges: Continuous type stainless steel or 11 gauge stainless wrap-around type. Hinges shall be self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
 - 2. Latch and Keeper: Manufacturer's standard cast aluminum or stainless steel surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
 - 3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.

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4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
5. Door Pull: Manufacturer's standard unit aluminum or stainless steel at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
 2. Brackets: Secure panels to walls and to pilasters with continuous brackets.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less than two fasteners. Hang doors to align tops of doors with tops of panels and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Floor-Anchors: Set pilasters with anchors penetrating not less than 2 inches(50 mm) into structural floor, unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
- D. Wall-Hung and Post-Supported Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10 21 13

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SECTION 10 22 33 – ACCORDION PARTITIONS

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:
 - 1. Manual accordion partitions.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Metal framing and supports are specified in Division 5 Section "Metal Fabrications."

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Acoustical Performance: Provide accordion partitions tested by a qualified independent testing agency for the following acoustic properties according to the following test method:
 - 1. Sound Transmission Requirements: Operable partition tested for laboratory sound transmission loss performance according to ASTM E 90, determined by ASTM E 413 and rated for a STC plus or minus 1 as follows:
 - a. Sound Transmission Class (STC): 39.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
 - 1. Product data for each type of accordion partition and accessory specified.
 - 2. Shop drawings showing location and extent of accordion partitions. Include plans,

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elevations, large-scale details of anchorages, and accessory items. Indicate unit conditions at openings, location and installation requirements for hardware, and direction of travel. Provide template drawings prepared by manufacturer showing location of items supported or anchored by permanent construction.

- B. Maintenance data for partition to include in the "Operating and Maintenance Manual" specified in Division 1.
- C. Acoustical test reports from and based on tests performed by qualified independent testing agency certifying that products and materials furnished comply with specified requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who is certified in writing by the accordion folding partition manufacturer as qualified to install the manufacturer's partition systems.
- B. Surface-Burning Characteristics: Provide a partition finish face with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or other testing and inspecting agencies acceptable to authorities having jurisdiction.
 - 1. Flame Spread: 25 or less.
 - 2. Smoke Developed: 450 or less.

1.6 WARRANTY

- A. The installation shall be guaranteed against defects in materials and workmanship for a period of two years from date of installation and acceptance for beneficial use. In addition, the pantographs, trolleys, and tracks are guaranteed for 10 years from the date of acceptance for beneficial use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Foldoor/Holcomb & Hoke Mfg. Co.
 - 2. Hufcor/AirWall.
 - 3. Modernfold, Inc.

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- B. Standard of quality shall be Modernfold Soundmaster Model 8M. Acoustical performance shall be tested at an independent testing facility in accordance with ASTM E90 test standards. Standard panel construction shall have obtained an STC rating on 39. Equivalent products by other manufacturers shall be approved.

2.2 MATERIALS

A. Product to be equal to top supported, manually operated:

1. Covers will be semi-rigid laminated construction with manufacturer's standard vinyl fabric providing wrinkle-free impact resistant surfaces. Covers shall have steel strips laminated within each fold for acoustical purposes. Covers shall be removable and replaceable in the field.
2. Covers shall have multi-ply sweepstrips top and bottom both sides of the partition for acoustical seal. The top sweepstrips shall be 1/2" and the bottom sweepstrips shall be 1-1/2".
3. The internal framing shall be of 14 gauge steel riveted to form "X" construction pantographs. Pantographs shall provide even extension and contraction without binding on straight runs of track or on curves. Pantographs shall have built-in stops to prevent over-extending. Partition shall have pantographs located at top and bottom, plus intermediate pantographs located no more than 4' on center for heights over 8'.
4. Vertical steel channel posts shall support pantographs at each end of the partition.
5. The lead post shall be trimmed with clear anodized aluminum and include mechanical latching and pull handles.
6. Weight of the partitions, in lbs. per sq. ft., shall be 4.0.

B. Suspension System:

1. Track shall be Soundmaster No. 5 of clear anodized architectural grade extruded aluminum alloy 6063-T6 and be as specified by manufacturer for best performance as governed by overall size and weight of partition.
2. Partition shall be supported by a 4-wheeled carrier at the lead post. Wheels to be of nylon-tired steel ball bearings. The lead carrier shall be adjustable to maintain proper alignment of the lead post to the jamb.
3. Intermediate carriers shall be spaced 18" on center and have two wheels of nylon-tired steel ball bearings.

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- C. Finishes: Face finish shall be factory applied reinforced vinyl fabric with woven backing, weighing not less than 21 oz. per lin. yard. Color shall be selected from manufacturer's standard color selector.

2.3 OPERATION

- A. Accordion door shall be manually moved from the storage area, pulled across the opening, and latched into the full height dual magnetically sealed jamb with the latching handle.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine flooring for compliance with requirements for installation tolerances and other conditions affecting the performance of accordion folding partitions.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. The complete installation of the operable wall system shall be by an authorized factory-trained installer and be in strict accordance with the approved shop drawings and manufacturer's standard printed specifications, instructions, and recommendations.
- B. Lubricate bearings and sliding parts. Adjust to ensure smooth, easy operation.

3.3 CLEANING

- A. Clean all accordion folding partition surfaces and adjacent surfaces. Avoid abrasive cleaners or solutions containing corrosive solvents. Use cleaning materials recommended by the manufacturer.

3.4 TRAINING

- A. Installer shall demonstrate proper operation and maintenance procedures to owner's representative.

END OF SECTION 10 22 33

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SECTION 10 28 00 – TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Toilet and bath accessories.
- B. Related Sections include the following:
 - 1. Division 10 Section "Toilet Compartments" for compartments and screens.

1.2 SUBMITTALS

- A. Product Data: Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.
- B. Setting Drawings: For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use designations indicated in the Toilet and Bath Accessory Schedule and room designations indicated on Drawings in product schedule.
- D. Maintenance Data: For accessories to include in maintenance manuals specified in Division 1. Provide lists of replacement parts and service recommendations.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise approved by Architect.
- B. Product Options: Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule.

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1. Other manufacturers' products with equal characteristics may be considered. See Division 1 Section "Substitutions."
2. Do not modify aesthetic effects, as judged solely by Architect, except with Architect's approval. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.4 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.5 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's Mirror Warranty: Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.
 1. Minimum Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide accessories fabricated by a single manufacturer.
- B. Basis-of-Design Product: The design is based on each toilet accessory specified. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.
 1. Toilet and Bath Accessories:
 - a. Bobrick Washroom Equipment, Inc.
 - b. Bradley Corporation.
 - c. American Specialties, Inc.

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2.2 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.
- C. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.
- D. Galvanized Steel Sheet: ASTM A 653/A 653M.
- E. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
- F. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.
- G. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
- H. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- I. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.3 FABRICATION

- A. General: Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
- B. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- C. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.

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- D. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.
 - 1. Provide galvanized steel backing sheet, not less than 0.034 inch and full mirror size, with nonabsorptive filler material. Corrugated cardboard is not an acceptable filler material.
- E. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:
 - 1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
- F. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Cement mirrors to wall with Palmer mastic. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.
- C. Install grab bars to withstand a downward load of at least 250 lbf , when tested according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

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3.3 TOILET AND BATH ACCESSORY SCHEDULE

- A. All model numbers specified are products of Bobrick Washroom Equipment Inc.
- A. Toilet Tissue dispenser:
 - 1. Provided by Owner and installed by Owner.
- B. Grab Bars:
 - 1. GB (number indicates required length): Basis of design, Model No. B5806.99
 - a. Stainless steel with concealed mounting and nonslip gripping surface.
- C. Sanitary Napkin Disposal:
 - 1. ND: Basis of design, Model No. B-270
 - a. Satin finish stainless steel, surface mounted key control.
- D. Soap Dispenser: Provided and installed by the Owner.
 - 1. SD: Surface-mounted with double-stick tape.
- E. Mirror Unit:
 - 1. MIR: Basis of design, Model No. B-165 1836;
 - a. Mirror with stainless steel frame; tempered glass.
- F. Mop and Broom Holder:
 - 1. MH: Basis of design, Model No. B-223 x 36
 - a. Stainless steel, satin finish, install one holder in each Janitor's Closet.
- G. Shower Rod & Curtain:
 - 1. PRC: Shower Rod: Basis of Design: Model No. B-6107.
 - 2. PRC: Shower Curtain: Basis of Design: Model No. 204-3
- H. Paper Towel Dispenser:
 - 1. Provided and installed by the Owner. Surface mounted.
- I. Shower Transfer Bench:
 - 1. STB: Basis of Design: Model Nos. B-5181 or B-5171.
- J. Shower Grab Bar:
 - 1. SGB: Basis of Design, Model No. B-6861

END OF SECTION 10 28 00

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SECTION 10 44 00 - FIRE- PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Fire Extinguishers: NFPA 10, listed and labeled for the type, rating, and classification of extinguisher.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS AND CABINETS

- A. Manufacturers:
 - 1. JL Industries, Inc.
 - 2. Kidde Fyrnetics.
 - 3. Larsen's Manufacturing Company.
 - 4. Modern Metal Products; Div. of Technico.
 - 5. Potter Roemer; Div. of Smith Industries, Inc.
 - 6. Watrous; Div. of American Specialties Inc.
- B. Portable Fire Extinguishers: Multipurpose dry-chemical type, 5 lb. capacity, UL-rated 2-A:10:B:C.
- C. Fire Extinguisher Cabinets:
 - 1. Larsen's Vista Series No. V-2709 or equal.
 - 2. Cabinet Material: Stainless Steel.
 - 3. Trim Style: Square trim.
 - 4. Trim Material: Stainless steel.
 - 5. Door Glazing: Rotating acrylic bubble.
- D. Where cabinets are shown recessed into rated walls, provide cabinets of an equal fire resistance rating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cabinets and brackets at heights indicated or, if not indicated, at heights to comply with applicable regulations of authorities having jurisdiction.

END OF SECTION 10 44 00

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SECTION 10 51 10 – METAL ATHLETIC LOCKERS

PART I - 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 Open Front, Knocked Down Team Lockers in spaces 101 and 108.

1.3 SUBMITTALS

- A. Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Shop Drawings: Show the following:
 - 1. Dimensioned drawings including plans, elevations, and sections to show locker locations and interfaces with adjacent substrates.
 - 2. Details of assembly, erection, anchorage and clearance requirements.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and finishes.

1.4.1 QUALITY ASSURANCE:

- A. Uniformity: Provide each type of metal locker as produced by a single manufacturer, including necessary accessories, fittings and fasteners.
- B. Job Conditions: Do not deliver metal lockers until building is enclosed and ready for locker installation. Protect from damage during delivery, handling, storage and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

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- A. Available Manufacturers: Athletic lockers specified are “Stadium” by Penco to establish design and quality levels. Manufacturers offering products that may be accepted as equals, subject to meeting Penco’s design and quality standards, including color match, include, but are not limited to, the following:

1. Art Metal Products, Div. of Fort Knox Storage Co.
2. De Bourgh Manufacturing Co.
3. The Interior Steel Equipment Co.
4. List Industries Inc.
5. Lyon Metal Products Inc.
6. Medart, Inc.
7. Republic Storage Systems

2.2 LOCKER DIMENSIONS:

- A. Open Front Knocked Down Team Lockers: 24” wide x 24” deep x 72” high with two lockable top compartments as shown on plans.

2.3 FABRICATION – GENERAL:

- A. Material: All major steel parts shall be made of cold rolled steel specially formed for added strength and rigidity, free from imperfections and capable of taking a high grade enamel finish.
- B. Finish: Surfaces of the steel to be thoroughly cleaned and phosphatized in a seven-stage process. All parts are then finished with a heavy coat of enamel, baked on at 300 degrees for 30 minutes.
- C Locker Body Construction: Stadium knock-down, steel specially formed for added strength and rigidity and to ensure tight joints at fastening points.
1. Sides, Bottoms, Tops, and Shelves: 16 gauge steel.
 2. Backs: Solid 18 gauge steel.
 3. Tops & bottoms shall be 16 gauge with three sides formed 90 degrees and the front offset formed to be flush with the horizontal frame member.
 4. Shelves shall be 16 gauge with four sides formed to 90 degrees, the front edge shall have a second bend.
 5. Hole Spacing in locker body construction: Not exceeding 9 inches
 6. Bottoms have two reinforcement channels for added strength.
 7. Optional Factory assembly of locker bodies using rivets.

2.04 INTERIOR EQUIPMENT

- A. Stadium Open-Front Athletic Lockers:
1. Full width shelf, coat rod, and two single prong hooks.

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2. Provide TWO Box locker security boxes, above shelf.
 - a. Doors shall be 14 gauge steel, punched for built-in locks or padlocks. Lock hole cover with door pull shall be provided for padlock use.
 - b. Hinges: 16 gauge continuous and riveted to 16 gauge welded frame
 - c. Side panel: 16 gauge
 - d. Provide a 1" diameter hole with plastic grommet in the top of each security box.
3. Foot locker with hinged bench seat, padlock hasp and stainless steel strike.
 - a. Hinge: 16 gauge continuous and riveted to horizontal panel
 - b. Ventilation: Front panel to have a pattern of mini louvers that measure ½" wide by ¼" high.

2.4 FABRICATION – ATHLETIC LOCKERS.

- A. Construction: Lockers shall be built on the unit principle, each locker shall have an individual door and frame, an individual top, bottom, back and shelves with common intermediate uprights separating units. Assembly of all locker components shall be by riveting with a backup washer to provide shake-proof permanent fastening while still permitting fastener removal by drilling to allow future rearrangement of lockers or replacement of damaged parts. Keps nuts and bolts may be used for assembly.
- B. Frames: Frames shall be 16-gauge steel formed into 1" wide face channel shapes with continuous stiffening members on both sides of the locker opening. Channel-shaped, 16 gauge top and bottom cross frame members shall be securely welded to vertical framing members to ensure a square and rigid assembly.
- C. Body: Locker body components shall be made of cold rolled steel specially formed for added strength and rigidity and to ensure tight joints at fastening points. 16-gauge side uprights are perforated with diamond shaped openings ¾" wide by 1 ½" high for maximum ventilation. Diamond pattern shall be located between the foot locker and the clothes hooks. Solid steel sections shall occur at the foot locker to provide closed compartments. Locker backs shall be 18-gauge steel with right angle flanges on each vertical side for stiffness, ease of assembly and corner rigidity. Tops, bottoms, shelves and compartment dividers shall be 16-gauge steel, fully flanged on all sides for added stiffness. Shelves shall have an additional return flange on the front edge creating a channel shape to rigidize the impact surface. All locker components are finished in the same color.
- D. The recessed opening shall contain a stainless steel strike plate and have a tapered bottom flange for number plate mounting. The hinged seat/lid shall be 14-gauge steel with right angle flanges on the sides of rear, and channel-shaped flanges across the front. The seat front shall be further reinforced with a 16-gauge box formation running side to side on which are mounted four rubber bumpers that bear on the top channel on the front panel. An additional 16 gauge reinforcing angle shall be

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welded to the underside of the lid midway between the front box formation and the rear flange. The seat/lid shall have a full width, continuous hinge riveted to the rear flange and welded to a 16-gauge channel-shaped hinge post attached to the locker back and sides. Two channel-shaped side fillers shall be mounted to the locker sides to provide supporting flanges along the sides of the seat/lid.

- E. Number Plates: Each locker shall have a polished aluminum number plate with black numerals not less than ½” high. Plates may be riveted to the shelf face with two rivets.
- F. Finish: Enamel powder coat paint finish electrostatically applied and properly cured to manufacturer’s specifications for optimum performance. Finishes containing volatile organic compounds and subject to out-gassing are not acceptable. Locker exterior and interior shall be painted the same color.
 - 1. Powder Coat - Dry Thickness: 1 to 1.2 mils (0.025 to 0.03 mm).
 - 2. Frames and all body parts shall be finished in color selected by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lockers must be installed in accordance with manufacturer’s approved drawings and assembly instructions. Installation to be level and plumb with flush surfaces and rigid attachment
 - 1. Space fasteners at 36” O.C. or less as recommended by manufacturer. Use fasteners appropriate to load and anchoring substratum. Use reinforcing plates wherever fasteners could distort metal.
 - 2. Bolt adjoining locker units together to provide rigid installation
 - 3. Various trim accessories where shown such as, fillers, bases, recess trim, etc., shall be installed using concealed fasteners. Flush, hairline joints are provided at all abutting trim parts and at adjoining surfaces.
- C. Adjustment: Upon completion of installation, inspect lockers and adjust as necessary for proper door and locking mechanism operations. Touch up scratches and abrasions to match original finish.

END OF SECTION 10 51 10

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SECTION 10 82 00 - ROOF TOP EQUIPMENT SCREENS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pre-formed painted metal panels for enclosing roof top mechanical equipment.
 - 2. Aluminum assembly framing for direct attachment of screening panels to mechanical equipment curb.
 - 3. Sliding panels to permit easy access to mechanical equipment for servicing.

1.2 REFERENCES

- A. American Society for Testing and Materials: Standard Specifications for
 - 1. ASTM B 221-96 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire Profiles, and Tubes.
- B. The Aluminum Association, Inc.
 - 1. AA ADM-1516166 (1994) - Aluminum Design Manual
- C. American Society of Civil Engineers.
 - 1. ASCE 7-95 - Minimum Design Loads for Buildings and Other Structures.

1.3 SYSTEM DESCRIPTION

- A. Design Criteria:
 - 1. Manufacturer is responsible for the structural design of all materials, assembly and attachments to resist snow, wind, suction and uplift loading at any point without damage or permanent set.
 - 2. Framing shall be designed in accordance with the Aluminum Design Manual to resist the following loading:
 - a. ASCE 7-95 - Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's catalog data, detail sheets, specification and other data sufficient to indicate compliance with these specifications.
- B. Shop Drawings: Indicate layouts heights, component connection details, and details of interface with adjacent construction. Mark data to indicate:
 - 1. Roof top mechanical equipment to be enclosed.

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- C. Samples:
 - 1. Samples of Materials: painted metal.
 - 2. Color Selection: Submit paint chart with full range of colors available for Architect's selection.
 - D. Certification: Manufacturer's Certificate of Compliance certifying that thermoplastic panels supplied meet or exceed requirements specified.
 - E. Closeout Submittals: Warranty documents, issued and executed by manufacturer, countersigned by Contractor.
- 1.5 QUALITY ASSURANCE
- A. Regulatory Requirements: Comply with requirements of building authorities having jurisdiction in Project location.
 - B. Manufacturer Qualifications: Minimum five (5) years documented experience producing systems specified in this section.
 - C. Pre-Installation Meeting:
 - 1. Convene at job site seven (7) calendar days prior to scheduled beginning of construction activities of this section to review requirements of this section.
 - 2. Require attendance by representatives of the installing subcontractor, (who will represent the system manufacturer) and other entities directly affected by construction activities of this section.
 - 3. Notify Architect four (4) calendar days in advance of scheduled meeting date.
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
 - B. Storage and Handling: Protect materials and finishes during handling and installation to prevent damage.
- 1.7 PROJECT CONDITIONS
- A. Field Measurements: Take measurements of actual roof top unit for fit without gaps. Indicate measurements on shop drawings fully documenting any field condition that may interfere with the screen system installation.
- 1.8 COORDINATION
- A. Installer for work under this Section shall be responsible for coordination of panel and framing sizes and required options with the Contractor's requirements.
 - 1. Request information on sizes and options required from the Contractor.

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- B. Submit shop drawings to the Contractor and obtain written approval of shop drawing from the Contractor prior to fabrication.

1.9 WARRANTY

- A. If any part of the rooftop equipment screen fails because of a manufacturing defect within one year from the date of substantial completion, the manufacturer will furnish without charge the required replacement part(s). Any local transportation, related service labor or diagnostic call charges are not included.
- B. This warranty does not cover failure of your rooftop equipment screen if it is damaged by the Owner, or if the failure is caused by improper installation. In no event shall Warrantor be liable for incidental or consequential damages.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Product: Envisor Screening System by CityScapes Incorporated, 4200 Lyman Ct. Hilliard, OH 43026. 1-877-727-3367 www.cityscapesinc.com
- B. Alternate Manufacturers: Subject to conformance with requirements, manufacturers offering systems that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Curbs Plus, Inc. , Rossville, GA

2.2 MATERIALS

- A. Painted Metal Panels: Fabricated from rigid aluminum panels in multiple thicknesses.
 - 1. Minimum thickness: 0.063
- B. Framing: Aluminum Plate, Shapes and Bar: ASTM B 221, alloy 6061-T5 or 6063-T5.
- C. Threaded Fasteners: All screws, bolts, nut and washers shall be Stainless steel.
 - 1. Corner assembly fasteners shall be #10-16 x stainless steel TEK screws. Length as required to develop full holding capacity of screw when fastened to Mechanical Equipment.
 - 2. Provide lock washer or other locking device at all bolted connections.

2.3 FABRICATION

- A. Provide factory-formed panel systems with continuous interlocking panel connections and indicated or necessary components: Form all components true to shape, accurate in size, square and free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.
- B. Fabricate all panels to slide horizontally to allow access to unit access panels behind.

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- C. Panel Design, Style, Trim:
 - 1. Panel Style: Vertical.
 - 2. Panel Design: 7.2 Rib Vertical Rib
 - 3. Decorative Top Trim Profile: Band
- D. Panel Height: 6'. Start panels 2' above roof level.
- E. Trim and Closures: Fabricated from 24 gage metal, and finished with the manufacturers standard coating system, unless shown otherwise on drawings.
- F. Framing: Fabricate and assemble components in largest practical sizes, for delivery to the site.
 - 1. Construct corner assemblies to required shape with joints tightly fitted.
 - 2. Supply components required for anchorage of framing. Fabricate anchors and related components of material and finish as required, or as specifically noted.

2.4 FINISHES

- A. Panel Coating: Manufacturer's standard coating system, factory-applied.
 - 1. Color: Selected from full range of manufacturer's standard colors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Installer's Examination: Examine conditions under which construction activities of this section are to be performed.
 - 1. Submit written notification to Architect and Screen manufacturer if such conditions are unacceptable.
 - 2. Beginning erection constitutes installer's acceptance of conditions.

3.2 INSTALLATION

- A. Install units in accordance with the manufacturer's instructions and approved shop drawings. Keep perimeter lines straight, plumb, and level. Provide brackets, anchors, and accessories necessary for a complete installation.
- B. Fasten structural supports to HVAC units without damaging operation of the unit.
 - 1. Provide corner and mid-span assemblies as required by approved shop drawings so that the panels are supported uniformly.
 - 2. Fastening bottom rail using bolts to permit ease of access to HVAC units.
- C. Insert thermoplastic panels into structural supports, except where fixed attachment points are indicated. Butt thermoplastic panels to adjacent panels for uniform fit. Fasten fixed panels in accordance with the shop drawings.

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- D. Metal Separation: Where aluminum materials would contact dissimilar materials, insert rubber grommets at attachment points, thus eliminating where dissimilar metals would otherwise be in contact.
- E. Do not cut or abrade finishes which cannot be restored. Return items with such finishes to shop for required alterations.

3.3 ERECTION TOLERANCES

- A. Maximum misalignment from true position: ¼ inch.

3.4 CLEANING AND PROTECTION

- A. Remove all protective masking from material immediately after installation.
- B. Protection:
 - 1. Ensure that finishes and structure of installed systems are not damaged by subsequent construction activities.
 - 2. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Architect.
- C. Prior to Substantial Completion: Remove dust or other foreign matter from component surfaces; clean finishes in accordance with manufacturer's instructions.

END OF SECTION 10 82 00

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SECTION 11 52 13 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide projection screens.

1.2 SUBMITTALS

- A. Submit product data for approval.

1.3 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Projection screens shall be equal to Draper Silhouette V Model, with 120-volt, 60 Hz, quick reversal motor. Provide 3-position key-operated control switch.
 - 1. Screen Type A to be 49" high x 87" wide, Matte white XT 1000V viewing surface, with black borders. Provide 1" black "extra drop".
 - 2. Screen Type B to be 45" high x 80" wide, Matte white XT 1000V viewing surface, with black borders. Provide 1" black "extra drop".

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install screens in accordance with manufacturer's instructions and approved submittals. Install screens and controls in proper relation with adjacent construction. Coordinate with work of other sections.
- B. Restore damaged finishes and test for proper operation. Clean and protect work from damage.

END OF SECTION 11 52 13

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SECTION 02005 – GENERAL SITEWORK REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. The provisions of the Contract Documents apply to the work of this section.

1.2 GENERAL REQUIREMENTS:

- A. **Scope of Work:** The work consists of providing all protection of monuments and bench marks, final grading, siltation control, stormwater management, storm sewer system, water system, sanitary sewer system, topsoiling, fertilizing, seeding and sodding of grass areas, curb and gutter, pavement, fencing, and related items necessary to complete work shown on drawings and specified here.
- B. **Monuments and Bench Marks:**
 - 1. Maintain carefully all monuments, property corners, and bench marks, and other reference points; if disturbed or destroyed, the Contractor shall have same replaced by a Civil Engineer or Land Surveyor registered in the State of Virginia, at his expense.
- C. **Laying Out of the Work:**
 - 1. The Contractor and/or Subcontractors affected shall, immediately upon entering project site, locate all general reference points, take such action necessary to prevent their destruction; lay out work and be responsible for all lines, elevations, measurements of building, grading, paving, utilities, and other work of the Contract. Exercise proper precaution to verify figures shown by the drawings before laying out work of the Contract. Exercise proper precaution to verify figures shown by the drawings before laying out work, be responsible for any error resulting from failure to exercise such precaution.
 - 2. When a Licensed Land Surveyor or Civil Engineer is not regularly employed by the Contractor, or Subcontractors as the case may be, Contractor shall engage such person for establishing bench marks, important key elevations and all major lines of work.
- D. **Sheeting, Shoring and Bracing:** The Contractor is responsible for providing, erecting and removing all sheeting, shoring and bracing necessary to complete the work in a safe and expeditious manner. Provide and maintain adequate pumping equipment as necessary to keep excavations dry.
- E. **Standard References:**
 - 1. Any materials, equipment, or workmanship specified by reference to the number, symbol, or title or any specific Standard shall comply with the latest edition or revision thereof and any amendment or supplement thereto in effect on the date of the Invitation to Bid, except as limited to type, class or grade, or modified in these specifications.

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2. Contractors must secure or review the pertinent Roanoke City, Virginia Department of Transportation Specifications, and the Virginia Department of Health regulations, details and regulations as pertain to the work.
- F. Asbestos: No materials or products used in this work shall be or contain asbestos.

1.3. OCCUPANCY OF THE PREMISES

- A. Upon signing the Contract, the Contractor shall occupy the Site for construction purposes and shall be responsible for protection and maintenance of the immediate construction site during the construction period. Care shall be taken to protect the property and utilities. Damages shall be repaired by and/or cost thereof borne by the Contractor.
- B. Erect and maintain any and all safeguards as may be necessary for the protection of the public, employees and persons, including enclosures, fences, temporary sidewalks, maintenance of lights, guards and signs that shall be required by jurisdiction involved.

1.4. MAINTENANCE OF TRAFFIC:

- A. At his expense, the Contractor shall provide for the maintenance of vehicular and pedestrian traffic as required by the Owner and Roanoke City.

1.5 CORRELATION OF PROJECT MANUAL & DRAWINGS:

- A. The Contractor shall examine and be familiar with the Site, drawings and Project Manual, Addenda (if issued), construction notes and other instructions, and shall at once report to the Architect any error, inconsistency, or omission which he may discover. He shall make such field checks as he deems necessary to verify topography and other data. The Contractor shall be held responsible for any error, inconsistency, or omission not called to the immediate attention of the Architect.
- B. Where a variance exists between these Project Manual specification sections and other standards and specifications referred to herein, these specifications shall govern. In the event of uncertainty as to interpretation, the Architect shall be notified immediately, and his decision shall be binding.

1.6. INSPECTION AND APPROVAL:

- A. The Contractor shall notify the Owner or Architect three (3) days prior to the beginning of any Sitework.
- B. Inspections under this contract will be by the Architect and/or the Civil Engineer and the Roanoke City Building Officials and Special Inspectors.

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1.7. PRE-CONSTRUCTION CONFERENCE:

- A. A pre-construction conference will be held at a time and place designated by the Architect and/or Owner to discuss job procedures, schedules and other matters with the Contractor and his superintendent prior to construction after the Contract has been awarded.

1.8. UNDERGROUND CONSTRUCTION & EXISTING FACILITIES:

- A. Information as to existing underground construction and sub-surface conditions is shown in accordance with the best available data. All must be investigated or verified in the field prior to, or upon construction by the Contractor. Location and elevation of points of pick-up or discharge of sanitary or storm sewer connections shall be verified prior to construction by the Contractor.

1.9. EXISTING UTILITIES:

- A. The extent, existence and locations of underground or other utilities, and other construction indicated on the plans are not guaranteed, and shall be investigated and verified in the field by the Contractor. Contractor shall notify "Miss Utility" prior to beginning work. Work in the vicinity of existing structures and utilities shall be carefully done by hand. The Contractor shall be held responsible for any damage to, and for maintenance and protection of, existing facilities and structures.
- B. Any existing structures, utility poles, lines, services, or other appurtenances located in, or affected by, the construction of the work herein shall be adjusted, moved or relocated as required. The work shall be performed by the Contractor of Utility Owner with arrangement and payment for said work being borne by the Contractor.

1.10. SAFETY:

- A. Except as thereafter provided, the current edition of Rules and Regulations Governing Construction, Demolition and all Excavation as adopted by the Safety Codes Commission of the Commonwealth of Virginia, and all provisions therein contained are hereby included as a part of these Specifications. (A manual setting forth these rules and regulations has been issued by the Department of Labor and Industry and may be obtained by writing the office at P. O. Box 1814, Richmond, VA 23214.)
- B. Proper safety precautions shall be exercised in all phases of work. The Architect shall require the use of any techniques or devices necessary to protect both workmen and the general public from injury or loss of life. It shall be the responsibility of the project foreman or superintendent to recognize and correct hazardous conditions whether or not he has received previous direction from the Architect.
- C. The current provisions of Article II of the Rules and Regulations, Governing Construction, Demolition, and all Excavation as adopted by the Safety Codes

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Commission, Commonwealth of Virginia shall apply, in their entirety, to all excavation work occurring in conjunction with the use of these specifications.

- D. Personal Protection: The provisions of Article VII of the aforementioned Rules and Regulations shall apply to insure the protection of workmen from hazards created by conditions to which workers are exposed. In addition to exercising all practical control to eliminate such hazards, or reduce them to a minimum, The Contractor shall also issue personnel equipment such as hard hats, and safety goggles where indicated by working conditions.
- E. Explosives: The provisions of the City Fire Code in conjunction with the Rules and Regulations Governing Manufacture, Storage, Handling, Use and Sale of Explosives, as adopted by the Safety Codes Commission of the Commonwealth of Virginia shall be strictly adhered to on all projects. Violators of any portion of these codes shall be prohibited from performance of further work until compliance with the codes is obtained. (Copies of these Rules and Regulations may be obtained from the Department of Labor and Industry, P. O. Box 1814, Richmond, VA 23214).
- F. Public Protection: The provisions of Article X of the Rules and Regulations Governing Construction Demolition, and all Excavation shall apply to insure adequate and safe protection to the general public whenever construction work is readily accessible to the public.

END OF SECTION 312005

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SECTION 312050 – CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The provisions of the Contract Documents apply to the work of this section.

1.2 DESCRIPTION OF WORK:

- B. In general, the items of work to be performed consist of clearing and grubbing, removal of all trees, stumps, roots and shrubs, and protection of trees to remain.

1.3 CLEARING:

- A. Remove all trees and stumps from areas to be occupied by new building, roads, surfaced areas, storm sewers, sanitary sewers, water lines, and temporary parking areas as shown on the plans. Trees outside these areas shall not be removed without permission from the Owner.
- B. All trees and stumps removed shall be taken out to a depth of two feet below the existing grade, or two feet below the excavation limits in areas to be excavated.
- C. All brush, poison ivy, stumps, wood, and other refuse from the trees shall be moved to disposal areas off the site. Disposal by burning onsite will not be permitted.
- D. The Contractor shall contact the Architect prior to beginning of clearing operations, and shall leave and protect any trees to be left on site as directed and marked by the Architect or Owner and in those areas of the site designated as tree protection areas on the plans
- E. Any debris left from clearing operations shall be removed from the site. No burying of stumps or other debris will be allowed on the site.

1.4 PROTECTION

- A. The Contractor shall be responsible for the protection of tops, trunks, and roots of existing trees on the project site that are to remain. Existing trees on the project site that are subject to construction damage shall be boxed, fenced, or otherwise protected before any work is started; remove boxing when directed. Do not permit heavy equipment or stockpiles within the branch spread of trees.
- B. Grading around trees where excavating, filling, or grading is required within the branch spread of trees that are to remain, the work shall be performed as follows:

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1. Existing trees in areas where the new finished grade is to be lowered, shall have re-grading work done by hand to elevation as indicated. Roots as required shall be cut cleanly 3" below finished grade and scars covered with tree paint.
2. In areas where trees are to remain and are included in the limits of sitework, all undergrowth and shrubs shall be removed by bush-hogging or other suitable methods.

END OF SECTION 312050

SECTION 312200 - EARTHWORK

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:

1. Preparing and grading subgrades for slabs-on-grade, walks, pavements, and landscaping.
2. Excavating and backfilling for buildings and structures.
3. Drainage and moisture-control fill course for slabs-on-grade.
4. Subbase course for walks and pavements.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling trenches within building lines.
7. Excavating and backfilling for underground mechanical and electrical utilities and appurtenances.

- B. Related Sections: The following Sections contain requirements that relate to this Section.

1. Division 31 Section "Clearing" for site stripping, grubbing, topsoil removal, and tree protection.
2. Division 32 Section "Lawns and Grasses" for finish grading, including placing and preparing topsoil for lawns and planting.
3. Division 32 Section "Sitework Concrete" for concrete encasings, cradles, and appurtenances for utility systems.

1.3 DEFINITIONS

- A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.
- B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

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- C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.
- D. Base Course: The layer placed between the subbase and surface pavement in a paving system.
- E. Drainage Fill: Course of washed granular material supporting slab-on-grade placed to cut off upward capillary flow of pore water.
- F. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Architect. Unauthorized excavation, as well as remedial work directed by the Architect, shall be at the Contractor's expense.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.
- H. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Test Reports: In addition to test reports required under field quality control, submit the following:
 - 1. Laboratory analysis of each soil material proposed for fill and backfill from borrow sources.
 - 2. One optimum moisture-maximum density curve for each soil material.
 - 3. Report of actual unconfined compressive strength and/or results of bearing tests of each stratum tested.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.
- B. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing.

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- C. Re-installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings." |
 - 1. Before commencing earthwork, meet with representatives of the governing authorities, Owner, Architect, consultants, Geotechnical Engineer, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least 3 working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

1.6 PROJECT CONDITIONS |

- A. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided. |
 - 1. Provide a minimum 48-hours' notice to the Architect and receive written notice to proceed before interrupting any utility.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shutoff services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations. |
- B. Satisfactory Soil Materials: ASTM D 2487 soil classification groups GC, SC, ML, CL, CH, GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 2 inches (50 mm) in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter. |
- C. Unsatisfactory Soil Materials: ASTM D 2487 soil classification groups OL, OH, and PT. |
- D. Backfill and Fill Materials: Satisfactory soil materials. |
- E. Base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, ASTM D 2940, with at least 95 percent passing a 1-1/2 inch (38 mm) sieve and not more than 8 percent passing a No. 200 (75 micrometer) sieve.
- F. Engineered Fill: Subbase or base materials.

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- G. Bedding Material: Subbase or base materials with 100 percent passing a 1 inch (25 mm) sieve and not more than 8 percent passing a No. 200 (75 micrometer) sieve.
- H. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate grading size 57, with 100 percent passing a 1-1/2 inch (38 mm) sieve and not more than 5 percent passing a No. 8 (2.36 mm) sieve.
- I. Filtering Material: Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand, with 100 percent passing a 1-1/2 inch (38 mm) sieve and 0 to 5 percent passing a No. 50 (300 micrometer) sieve.
- J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Tree protection is specified in the Division 31 Section "Site Clearing."

3.2 DEWATERING

- A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

3.3 EXCAVATION

- A. Explosives: Explosives may not be utilized,
- B. All excavating and grading is unclassified.

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3.4 STABILITY OF EXCAVATIONS

- A. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1.2 inches. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for new construction to be built over the footprint of demolished construction: As this area will be backfilled to support the new construction, excavation in this area shall extend at least five (5) feet beyond the perimeter of any new footings.
- B. Rock which is encountered in a footing excavation shall be excavated 12" below the bottom of the footing and replaced with a layer stone of other suitable material as directed by the Soils Engineer.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated slopes, lines, depths, and invert elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches (300 mm) each side of pipe or conduit or as indicated.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells,

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joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading. |

1. For pipes or conduit less than 6 inches (150 mm) in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
3. Where encountering rock or another unyielding bearing surface, carry trench excavation 6 inches (150 mm) below invert elevation to receive bedding course. |

3.8 APPROVAL OF SUBGRADE

- A. Notify Soils Engineer when excavations have reached required subgrade.
- B. When Architect or Soils Engineer determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Architect.

3.9 UNAUTHORIZED EXCAVATION |

- A. Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to the Architect.
 1. Fill unauthorized excavations under other construction as directed by the Architect.
- B. Where indicated widths of utility trenches are exceeded, provide stronger pipe, or special installation procedures, as required by the Architect.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

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3.11 BACKFILL

- A. Backfill excavations promptly, but not before completing the following:
 - 1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 - 2. Locations of underground utilities for record documents.
 - 3. Testing, inspecting, and approval of underground utilities.
 - 4. Concrete formwork removal.
 - 5. Removal of trash and debris from excavation.
 - 6. Removal of temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.12 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches (450 mm) of footings. Place concrete to level of bottom of footings.
- C. Provide 4 inch (100 mm) thick concrete base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installation and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase.
- D. Place and compact initial backfill of satisfactory soil material or subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.
 - 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
- E. Coordinate backfilling with utilities testing.
- F. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.
- G. Place and compact final backfill of satisfactory soil material to final subgrade.

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3.13 FILL

- A. Preparation: Remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.
 - 1. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface. |
- B. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density.
- C. Place fill material in layers to required elevations for each location listed below. |
 - 1. Under grass, use satisfactory excavated or borrow soil material.
 - 2. Under walks and pavements, use subbase or base material, or satisfactory excavated or borrow soil material.
 - 3. Under steps and ramps, use subbase material.
 - 4. Under building slabs, use drainage fill material. |
 - 5. Under footings and foundations, use engineered fill.

3.14 MOISTURE CONTROL |

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air-dry satisfactory soil material that is too wet to compact to specified density. Stockpile or spread and dry removed wet satisfactory soil material.

3.15 COMPACTION |

- A. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure. |
- C. Percentage of Maximum Dry Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D-698 (Standard Proctor):

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1. Under structures, building slabs, steps, and pavements, compact the top 12 inches (300 mm) below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
2. Under walkways, compact the top 6 inches (150 mm) below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
3. Under lawn or unpaved areas, compact the top 6 inches (150 mm) below subgrade and each layer of backfill or fill material at 90 percent maximum dry density.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between existing adjacent grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Lawn or Unpaved Areas: Plus or minus 1.2 inches (30 mm).
 2. Walks: Plus or minus 1.2 inches (30 mm).
 3. Pavements: Plus or minus 2 inch (13 mm).
- C. Grading Inside Building Lines: Finish subgrade to a tolerance of 2 inch (13 mm) when tested with a 10 foot (3 m) straightedge.

3.17 SUBBASE AND BASE COURSES

- A. Under pavements and walks, place subbase course material on prepared subgrades. Place base course material over subbases to pavements.
 1. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections and thickness to not less than 95 percent of ASTM D-698 or in accordance with VDOT specifications.
 2. Shape subbase and base to required crown elevations and cross-slope grades.
 3. When thickness of compacted subbase or base course is 6 inches (150 mm) or less, place materials in a single layer.
 4. When thickness of compacted subbase or base course exceeds 6 inches (150 mm), place materials in equal layers, with no layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick when compacted.

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3.18 DRAINAGE FILL |

- A. Under slabs-on-grade, place drainage fill course on prepared subgrade.
 - 1. Compact drainage fill to required cross sections and thickness.
 - 2. When compacted thickness of drainage fill is 6 inches (150 mm) or less, place materials in a single layer.
 - 3. When compacted thickness of drainage fill exceeds 6 inches (150 mm) thick place materials in equal layers, with no layer more than 6 inches (150 mm) thick nor less than 3 inches (75 mm) thick when compacted.

3.19 FIELD QUALITY CONTROL |

- A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements. |
 - 1. Perform field in-place density tests according to ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2937 (drive cylinder method), as applicable. |
 - a. Field in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.
 - b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect. |
 - 2. Footing Subgrade: At footing subgrades, perform at least one test of each soil stratum to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of each subgrade with related tested strata when acceptable to the Architect. |
 - 3. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.
 - 4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet (30 m) or less of wall length, but no fewer than two tests along a wall face.
 - 5. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet (45 m) or less of trench, but no fewer than two tests.

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- B. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.20 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris. |
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace material to depth directed by the Architect; reshape and recompact at optimum moisture content to the required density.
- C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Transport surplus satisfactory soil to be reused to designated storage areas on the Owner's property. Stockpile or spread soil as directed by Architect. |
 - 1. Remove surplus satisfactory soil and all waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION 322200

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SECTION 312215 - BUILDING EXCAVATION AND BACKFILLING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. The provisions of the Contract Documents apply to the work of this section.

1.2 DESCRIPTION

- A. The work specified in this Section includes foundations, footings and utility excavation within the building and backfilling of these same excavations.
- B. Rough grading to bring existing grades of the building areas to new subgrade elevation indicated on drawings shall be as specified in Section 322200.
- C. Suitable, approved excavated material may be used for fills and backfills. All deficient quantity of suitable, approved fill material, necessary for this project, shall be brought on-site by the Contractor at his expense. Excess excavated material shall be properly disposed of off-site at Contractor's expense.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1. EXCAVATION FOR STRUCTURES:

- A. Excavate to elevations and dimensions indicated. Allow additional space as required for the installation of waterproofing and dampproofing and other construction operations and inspecting foundations.
- B. Where soil conditions will permit clean-cut trenches without cave-ins, footing trenches may be excavated to the exact dimensions of the concrete and side forms omitted. Place footings upon undisturbed and firm bottoms; fill any excess cut under footings with concrete. Fill excess cut under slabs with gravel and thoroughly compact. Lowering of footings below the indicated elevations when directed because of poor soil, shall be done as a part of this contract. When unsuitable soil conditions are encountered, immediately notify the Architect. Do not proceed until Owner's Representative and Contractor confirm elevations, measurements are taken, and instructions given. Contractor shall take all responsibility for trench safety.

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- C. Subgrade for floor slabs on grade shall be set at proper elevation to allow porous gravel fill under slab to be thickness as indicated, but in no case, less than 4 inches.
- D. Do not place footings or slabs on frozen ground. When freezing temperature may be expected, do not excavate to the full depth indicated, unless the footings or slabs can be placed immediately after the excavation has been completed. Protect the excavated bottom of footings from frost, if placing of concrete is delayed. Protect footings from freezing after pouring until sufficient backfill is in place for protection.
- E. Bracing of Trenches: The Contractor shall provide bracing and support for all excavations as required to prevent injury to construction personnel and in accordance with current Occupational Safety and Health Administration (OSHA) requirements.
- G. Excavations shall be kept free from water at all times until permanent work in excavations has been completed and has been inspected and approved. Necessary pumping equipment shall be provided, operated and maintained as required.

3.2 BACKFILLING:

- A. Backfill against foundation and retaining walls only after approval of the Architect has been obtained. Place and compact backfill so as to minimize settlement and avoid damage to the walls and to waterproofing and other work in place.
- B. Before placing fill, remove all debris subject to termite attack, rot or corrosion, and all other deleterious materials from areas to be backfilled. Deposit backfill in layers not more than 6 inches thick. All fill material shall be reasonably free from roots, plaster, batts and unsuitable material. Stones larger than 3 inches maximum dimension shall not be permitted in the upper 12 inches of fill. Place the fill material in successive horizontal layers, in loose depth as specified, for the full width of the cross section. Thoroughly compact each layer by rolling or pneumatic tamping after a light sprinkling with water. The finished subgrade shall be brought to elevations indicated and sloped to drain water away from the building walls. Fill to required elevations any areas where settlement occurs.
- C. Each layer of backfill shall be compacted to meet the requirements of Section 312200 - Earthwork.
- D. Backfill against walls shall be brought up evenly on both sides. Any wall cracked or out of alignment, waterproofing or dampproofing damaged due to backfilling operations shall be replaced at the Contractor's expense. All bracing shall be removed as backfilling progresses.

END OF SECTION 312215

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SECTION 312500 - PROJECT CLEAN UP, RESTABILIZATION AND RESTORATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. The provisions of the Contract Documents apply to the work of this section.

1.2 DESCRIPTION:

- A. This section includes clean-up, restabilization and restoration required to prevent accidents, to protect all work in place, restabilize and restore all disturbed areas, removal of all evidence of construction activities and to effect completion of the project in an orderly manner, all to the satisfaction of the Owner.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CLEAN-UP:

- A. Construction clean up shall proceed as construction progresses and shall consist of the removal of all mud, oil, grease, soil, gravel, trash, scrap debris and excess material that are unsightly or may cause the tripping or sliding of workmen, or equipment. All cleaning materials and equipment used shall be selected and employed with care to avoid scratching, marring, defacing, straining or discoloring the surfaces cleaned.
- B. Immediately prior to the Contractor's written request for final inspection of the project or any portion thereof, perform final clean up.
- C. In addition to the normal "broom clean" requirements, the exposed surfaces of the following materials shall be cleaned as listed herein:
 - 1. Asphalt Paving: Remove mud, dirt, oil, and trash and hose down if required.
 - 2. Other Surfaces: Remove all blemishes, leave clean, uniform and dust free.
 - 3. Premises & Site: Remove all trash, debris, and surplus excavation material.
- D. No items shall be left or discarded elsewhere on the site. Items that are to be discarded shall be disposed of legally off-site. Leave premises "broom clean".

3.2 RESTORATION AND RESTABILIZATION:

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- A. All areas disturbed by the Contractor's operations including staging and stockpiling areas, construction strips, access roads, and areas within the right of way shall be restored and restabilized as specified herein.
- B. Final restoration and restabilization including seeding, sodding, landscaping and paving when season permits, shall proceed immediately after construction activity is completed in a given area. The Contractor shall tear down and remove all temporary construction facilities constructed by the Contractor and leave the site in an orderly condition as required by the Contract Documents.
- C. Preserve public and private signs, markers, guardrails and fences and maintain their original condition unless written permission is obtained for their removal and replacement. Remove such conflicting facilities when grading operations begin, store in a manner to keep them clean and dry and re-erect at such new locations to prevent damage to underground or overhead utility structures. Replace damaged items at no cost to the owner.
- D. Gravel surface and shoulders shall be restored to original condition. Do not reuse shoulder material if contaminated by foreign material. In such case, replace with new material of same quality and gradation. Materials and methods of construction shall be in accordance with jurisdictional requirements and with applicable permits secured for the contract. Areas adjacent to shoulders, if left unstable shall be surfaced and stabilized with gravel.
- E. Clean the Project site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste materials, litter and foreign substances. Sweep paved areas broom clean. Remove petrochemical spills, stains and other foreign deposits. Rake grounds that are neither planted nor paved, to a smooth even-textured surface.

3.3 DISPOSAL OF WASTE MATERIALS:

- A. Construction waste materials shall be disposed of legally off-site or in an area covered by a current grading or sediment control permit.
- B. Waste materials disposed of in an unauthorized location shall be removed by the Contractor and the area shall be restored to its original condition at no additional cost to the Owner.
- C. Removal of Condemned Materials:
 - 1. Material brought upon the grounds or selected for use in the work which has been determined by the Architect or Engineer to be unsuitable or not in conformity with the Contract Documents shall be removed from the vicinity of the work without delay and disposed of in an approved area.

END OF SECTION 312500

SECTION 31 31 16 - TERMITE CONTROL

PART 1) - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment with termiticide.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include the EPA-Registered Label for termiticide products.

B. Product certificates.

C. Soil Treatment Application Report: Include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Warranties: Sample of special warranties.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

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- B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground- supported slabs before construction.

1.5 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re- treat soil and repair or replace damage caused by termite infestation.

- 1. Warranty Period: Five years from date of Substantial Completion.

1.6 MAINTENANCE SERVICE

- A. Continuing Service: Beginning at Substantial Completion, provide 3 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2) - PRODUCTS

2.1 SOIL TREATMENT

- A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation, Agricultural Products; Termidor.
 - b. Bayer Environmental Science; Premise 75.
 - c. Syngenta; Demon MAX.
- 2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

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PART 3) - EXECUTION

3.1 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.2 APPLYING SOIL TREATMENT

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.
- C. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 - 1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.
- D. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA- Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
 - 1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 - 2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
 - 3. Crawlspace: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
 - 4. Masonry: Treat voids.
 - 5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
- E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

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- F. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
- G. Post warning signs in areas of application.
- H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION

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SECTION 32 31 00 - FENCES AND GATES

PART 1 - GENERAL

1.1_SCOPE

- A. Description of Work: Provide all permanent security fencing and gates indicated on the drawings, as specified herein, and as needed for a complete and proper installation.

1.2_QUALITY ASSURANCE

- A. Chain Link Fence Manufacturer's Institute

1.3_SUBMITTALS

- A. Technical information and details of construction showing gates, posts, bracing and other components.

PART 2 - PRODUCTS

2.1 FENCE TYPES

- A. Fence shall be 6'-0" high with black vinyl-coated fabric, posts and rails to match existing. No barbed wire.

2.2 MATERIALS

- A. Material and accessories shall be supplied by one of the following manufacturers:

1. Anchor Fence, Baltimore, Maryland
2. Chain-Link Fence Company of Pennsylvania
3. Cyclone Fence by U. S. Steel
4. General Wire and Cable Company
5. National Fence Manufacturing Company

- B. Chain Link Fabric: ASTM A-392, Class 1, commercial quality, medium high carbon, galvanized after weaving, steel wire fabric. Nine (9) gauge x two (2) inch mesh x 6'0" high. Provide black vinyl-coated fabric to match existing.

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- C. Posts: ASTM A-120, schedule 40 or structural grade pipe, spaced not further than ten feet (10') apart, hot dip galvanized inside and out, all posts to have tops. Provide black vinyl coated material.
- E. Line Posts: Standard 2.375 inch O.D. 3.117 pounds per foot, steel pipe. Maximum spacing ten (10) feet. Provide black vinyl coated material.
- F. Line Corner, Terminal and Gate Posts: Standard 2.875 inch O.D. 4.64 pounds per foot, steel pipe. Provide black vinyl coated material.
- G. Gate Posts: Type I, 6.625 inch O.D. 18.97 pounds per foot. Extend 4'0" into the ground. Provide black vinyl coated material.
- H. End, Corner and Gate Posts: Shall be braced to the adjacent line posts with a 1.660 inch O.D. SS-20 pipe weighing 1.83 lbs. per linear foot and a 3/8" adjustable truss rod with turn buckle tightener. Provide black vinyl coated material.
- I. Top Rail and Bracing: ASTM A-120, schedule 40 or structural grade pipe, 1.660 inch O.D. 2.27 pounds per foot. Hot dip galvanized inside and out. Top rail of twenty-one (21) foot lengths joined by six (6) inch long sleeves, to run continuously along top of fence. Provide black vinyl coated material.
- J. Gate Frames: Shall be tubular steel of sufficient size and weight to securely support the gate structure. Sizes and weights to comply with minimum requirements and standards of the Chain Link Fence Manufacturer's Institute. Frames shall be joined at the corners by arc welding to form a rigid one piece panel and filled with the same fabric used as fencing. Where welded, paint with liquid galvanized compound. Provide black vinyl coated material.
- K. Personnel and Vehicle Gates: Swing types with perimeter frame; operating hardware to include forked type latch with padlock eye, and non-lift off hinges to allow 180 degrees operation. Provide black vinyl coated material.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fencing in locations shown on drawings. Tie into existing fencing where required.
- B. Verticals installed plumb in concrete foundations of sufficient size and depth to sustain them vertically when fabric tension is applied.
- C. Chain link fabric shall be stretched to proper tension between terminal posts and securely fastened to the frame work members.

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- D. Install fabric so that fence barbs extend 1.5" above top rail.
- E. Fabric connections, attachment to terminal posts with tension bars and tension bands, spaced fifteen (15) inch maximum. Fabric to be attached to line posts, top rail with nine (9) gauge zinc coated wire clips twelve (12) inches on centers.
- F. Gates shall be size and type shown on drawings, complete with all latches, stops, keepers and hinges. Fitting of malleable or ductile iron, hot dip galvanized after fabrication.
- G. Gates shall be same height as fence in which they are installed.
- H. Set line corner, terminal and gate post approximately 4'-0" below finish grade by driving them into soil. Any posts that are not sufficiently stable shall be set in concrete.

END OF SECTION 32 31 00

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SECTION 325015 – SITEWORK CONCRETE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. The provisions of the Contract Documents apply to the work of this section.

1.2 DESCRIPTION:

- A. This Section includes concrete for exterior sitework only. Building concrete is specified in Section 033000, Cast-in-Place Concrete..

1.3 SUBMITTALS

- A. Submit for approval product data, mix design, mock-ups, test reports.

1.4 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

- A. Portland Cement shall conform to ASTM "Standard Specifications for Air-Entraining Portland Cement" C175-43T.
- B. Coarse Aggregate: Hard, durable, uncoated crushed stone conforming to ASTM C-33-52-T.
- C. Sand: Clean, hard, durable, uncoated grains free from silt, loam and clay.
- D. Water: Shall be clean and free from oils, acid, alkalies, organic materials and other deleterious substances.
- E. Concrete for concrete sidewalks, paving, curb and gutter, equipment pads, and other miscellaneous sitework concrete shall be air-entrained with a 28-day comprehensive strength of 3,500 psi, Class A-3 concrete. Virginia Department of Transportation "Road and Bridge Specifications", Section 217, Portland Cement Concrete shall apply to all concrete work for curb and gutter and sidewalks.
- F. Reinforcing Bars: New billet steel, ASTM A615, Grade 40.

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PART 3 - EXECUTION

3.1 CURB AND/OR GUTTER:

- A. Sub-grade shall be brought to proper lines and grades and compacted as specified in Section 312200. Report unsatisfactory conditions in writing. Beginning concrete work means acceptance of subgrade.
- B. Curbs shall meet all requirements of the City of Roanoke Specifications and shall be poured and constructed in a workmanlike manner.
- C. Any Curb having a radius of 300' or less shall be considered radial curb and shall be constructed using wooden or flexible forms. Curb shall be poured in approximately 10' lengths with no section less than six (6) feet.
- D. All exterior concrete shall be cured with an approved membrane spray, sanding and continuous wetting, or covered with an approved material.
- E. Tolerances for all exterior concrete curb and gutter shall be as follows:
 - 1. All concrete which is out of shape, plane, or design 1/4" or more when tested with 10' straight edge shall be removed and replaced.
 - 2. Any concrete curb that becomes chipped, spauled, cracked or otherwise damaged prior to final acceptance of the project shall be removed and replaced at the Contractor's expense. No patching shall be permitted. (Portions of sections may be replaced using an epoxy type method only if approved by the Architect.)

3.2 SIDEWALKS AND EQUIPMENT PADS:

- A. Sub-grade shall be brought to proper lines and grades and compacted as specified in Section 312200. Report unsatisfactory conditions in writing. Beginning concrete work means acceptance of subgrade.
- B. Sidewalks shall be one course construction, 4" in thickness unless otherwise indicated on drawings. Provide 1/2" expansion joints not more than 30 feet apart. Provide expansion joints where sidewalks abut curb. Pre-molded expansion strips shall extend for the full width and depth at required locations. Walks shall be scored at five (5) foot intervals for their full width. Provide fine bristled stiff broom finish. All pedestrian walks shall be reinforced with one layer of 6x6-W1.4 x W1.4 WWF, broken at all joints. Equipment pads shall have a minimum thickness and reinforcing as indicated on the plans.
- C. All concrete sidewalks and equipment pads shall be poured on compacted granular material. The granular material shall be a crushed stone which will pass a 3/4" sieve, but will be retained on a No. 4 sieve. The stone shall have a minimum thickness under the walk or pad as shown on the plans.
- D. When sidewalk is poured adjacent to curb, expansion joints, if practical, shall coincide.

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3.3 ENTRANCE APRONS AND CONCRETE PAVING:

- A. Sub-grade shall be brought to proper lines and grades and compacted as specified in Section 312200. Report unsatisfactory conditions in writing. Beginning concrete work means acceptance of subgrade.
- B. Entrance Aprons shall be in accordance with City of Roanoke Standards, and of design and dimensions shown on the drawings.
- C. Concrete Paving shall be one course construction, 6" in thickness unless otherwise indicated on the drawings. Provide ½" expansion joints where paving abuts adjoining surfaces. Pre-molded expansion strips shall extend for the full width and depth at required locations. Concrete paving shall be scored at maximum eight (8) foot intervals , both directions. Provide fine bristled stiff broom finish. Concrete Paving shall have a minimum thickness and reinforcing as indicated on the drawings.
- D. All entrance aprons and concrete paving shall be poured on compacted granular material. The granular material shall be a crushed stone which will pass a 3/4" sieve, but will be retained on a No. 4 sieve. The stone shall have a minimum thickness under the apron or paving as shown on the plans.

3.4 WEATHER:

- A. All concrete poured in cold weather or between the dates of November 1 and April 1 shall be poured in accordance with the Virginia Department of Transportation limitations "cold weather concrete" and shall be protected according to these specifications. Before any concrete shall be poured, necessary material for protection of this concrete shall be on the Site.

END OF SECTION 325015

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SECTION 327000 - IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. Drawings and general provision of Contract, including General and Special Conditions, apply to work of this section.

1.2 DESCRIPTION

1. A complete underground irrigation system for the practice field to the east of the building. The system includes piping, fittings, sprinkler heads, controller and accessories.
2. Repair any damage to the existing system that occurs during the construction work.

1.3 QUALITY ASSURANCE

1. Installer's qualifications:
 1. Upon request, contractor must provide the following, to include name of contact, name of project, address of project, & phone number of contact. If this criteria cannot be met, then contractor may be disqualified:
 1. Virginia class A contractor's license showing a specialty in irrigation in continued force for the last 5 years.
 2. Five verifiable references in Virginia to attest to the contractors ability to install. Projects of the size and complexity of this project.
 2. Contractor's primary business is to be irrigation installation. Primary defined as 60% of the contractors business is to be derived from irrigation installation. Verification may be required.
 3. Conform to applicable codes for piping and component requirements.

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4. Materials, equipment, and methods of installation shall comply with the following codes and standards:
 1. Western Virginia Water Authority.
 2. National Fire Protection Association, (NFPA): National Electrical
 3. Code.
 4. American Society of Testing and Materials, (ASTM).
 5. National Sanitation Foundation, (NSF).

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1.5 DELIVERY, STORAGE, AND HANDLING

1. Deliver irrigation system components in manufacturer's original undamaged and unopened containers with labels intact and legible. Site contractor will provide staging area.
2. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded or plain.
3. Store and handle materials to prevent damage and deterioration.
4. Provide secure, locked storage for valves, sprinkler heads, and similar components that cannot be immediately replaced, to prevent installation delays.

1.6 PROJECT CONDITIONS

1. Known underground and surface utility lines are indicated on the utilities drawings.
2. Protect existing trees, plants, lawns, and other features designated to remain as natural area.
3. Promptly repair damage to adjacent facilities caused by irrigation system work operations. Cost of repairs at Contractor's expense.
4. Irrigation system layout is diagrammatic. Exact locations of piping, sprinkler heads, valves, and other components shall be established by Contractor and the Owner in the field at time of installation. Contractor will stake mainline and all heads and valves and receive approval from Owner prior to excavation. Contractor is ultimately responsible for maintaining 100% coverage on entire irrigated site.
 1. Space sprinkler components as indicated.
 2. Minor adjustments in system layout will be permitted to clear existing fixed obstructions. Final system layout shall be acceptable to the Architect and Owner.
5. Cutting and patching:
 1. Cut through concrete and masonry with core drills. Jack hammers not permitted.
 2. Materials and finishes for patching shall match existing cut surface materials and finish. Exercise special care to provide patching at openings and exterior walls.

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3. Methods and materials used for cutting and patching shall be acceptable to the Architect.

PART 2 - PRODUCTS

2.1 MATERIALS

1. Plastic pipe, fittings, and connections:
 1. Polyvinyl chloride pipe: ASTM D2241, rigid, un-plasticized PVC, extruded from virgin parent material. Provide pipe homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents.
 1. 1" – 2.5" diameter : SDR21, Class 200, glue end PVC.
 2. 3" diameter: SDR21, Class 200, bell end PVC
 2. PVC pipe glue end fittings: ASTM D2241 schedule 40 PVC molded fittings suitable for solvent weld connections. Fittings made of other materials are not permitted. Saddle and cross fittings not permitted.
 3. Fittings size 3" shall be ductile iron as manufactured by Harco or approved equal. Tap tees to service sprinkler heads shall be PVC.
 4. Insert fittings: ASTM D2466 insert type fittings.
3. Swing Joints
 1. Swing joints for sprinkler shall be PVC, model #G132-212 as manufactured by Lasco. All threaded connections shall be made with Teflon tape.
4. Controllers, valves, sleeves, and associated equipment: Provide manufacturer's data on each type of equipment to obtain Owner's approval.
 1. Valves
 1. Automatic remote control valves (RCV) shall be sized as specified on drawings. RCV's shall be installed per manufacturer's recommendations and shall be rated for pressure and flow as required. RCV's shall be low voltage. Valves shall be constructed of plastic. Valves shall be the P220-26-06 1.5" model as manufactured by The Toro Company, Riverside, California. The valves shall be as follows:
 1. 220 PSI maximum pressure rating
 2. 5-year warranty

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3. Self-cleaning, stainless steel rod
 4. Standard built-in the body Schrader style valve
 5. Flow control independent of the solenoid
 6. External manual bleed.
 7. Tough, double-beaded fabric rubber diaphragm rated at 750 psi.
2. Wire
 1. Control wire shall be 14/1 gauge UL/UF, direct burial red in color. Common wire shall be 14/1 gauge UL/UF, direct burial white in color.
 2. All wire splices below grade shall be made water proof with correctly sized wire splice connectors, made for direct burial and rated for minimum of 30 volts.
 3. An extra wire shall be run from the controller along all mainline piping.
 4. Wire shall be color coded. White is to be used for common, red is to be used for control, and blue for extra. Any deviation will be replaced.
 3. Field controllers
 1. Field controller is a Toro Custom Command 18-station controller as specified on the irrigation plan.
 2. Sprinklers
 1. Sprinklers shall be of the following models:
 - a. All ProSport series gear drive sprinklers shall be as follows:
 - i. Flow rate of 11.8 gpm with 60 psi at the base of the head.
 - ii. Triple nozzle configuration
 - iii. Standard rubber cover
 - iv. Stainless steel encased nozzle and drive assembly
 - v. 1" NPT female thread inlet size
 - vi. Trajectory: 26°
 - b. All sprinklers are as manufactured by K-Rain, Riviera Beach, Florida. All ProSport series sprinklers must be installed on inlet sized PVC pre-assembled swing joints.

PART 3 - EXECUTION

3.1 INSPECTION

1. Examine final grades and installation conditions. Verify that field measurements are as shown on drawings. Do not start irrigation system repair work until unsatisfactory conditions are corrected.
2. Verify that required utilities are available, in proper location, and ready for use.

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3. Beginning of installation means installer accepts existing conditions.
4. Contractor must provide one experienced on-site foreman or supervisor subject to approval of the irrigation designer, who must be on site at all times when a crew is working.

3.2 PREPARATION

1. Prior to excavation, utility companies shall be notified in accordance with local codes and ordinances. Contractor must contact Miss Utility prior to beginning of installation. All current Miss Utility rules for contact and digging will be followed.
2. Contractor shall be responsible for damage to existing utilities and structures due to negligence and/or misuse by his crews or equipment.
3. Place sleeves as necessary for installation of piping and control wire. All piping under walks and walls shall be within a Class 200 PVC sleeve 2 sizes larger than the pressure pipe.

3.3 INSTALLATION

1. Excavating and back filling:
 1. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings.
 2. Excavate to depths required to provide 3" depth of debris free earth fill or sand bedding for piping when rock or other unsuitable bearing material is encountered.
 3. Fill to match adjacent grade elevations with approved earth fill material. Place and compact fill in layers not greater than 8" depth.
 1. Provide approved earth fill or sand to a point 4" above the top of pipe.
 2. Fill to within 6" of final grade with approved excavated or borrow fill materials free of lumps or rocks larger than 1" in any dimension.
 3. Provide clean topsoil fill free of rocks and debris for top 6" of fill.
 4. Install irrigation lateral lines with a minimum cover of 18" based on finished grades. Install irrigation mainline with a minimum of 24" based on finished grade.

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5. Excavate trenches and install piping and fill during the same working day. Do not leave open trenches or partially filled trenches open overnight.
 1. Replace stripped sod in sufficient time to allow for satisfactory sod recovery and growth. Water stripped and reinstalled sod until irrigation system is place in operation.
 6. Valves boxes installed per specifications on design.
 7. All gasketed pvc pipe must be thrust blocked at all gasketed fitting connections. This includes any gasketed gate valve assemblies. Thrust block must be poured against native soil compaction. Utilize rebar as necessary. Brick, block or stone will not be acceptable thrust block material.
2. Plastic pipe:
1. Install plastic pipe in accordance with manufacturer's installation instructions. Provide for thermal expansion and contraction. Do not install plastic pipe if temperature is below 32 degrees.
 2. Saw cut plastic pipe. Use an electric miter saw, to ensure a square cut. Remove burrs and shavings at cut ends prior to installation.
 3. Make plastic to plastic joints with solvent weld joints or slip seal joints. Use only solvent recommended by the pipe manufacturer. Install plastic pipe fittings in accordance with pipe manufacturer's instructions. Contractor shall make arrangements with pipe manufacturer for all necessary field assistance.
 4. Make plastic to metal joints with plastic male adapters.
 5. Make solvent weld joints in accordance with manufacturer's recommendations.
 6. Allow joints to set **at least 24 hours** before pressure is applied to the system.
 7. Maintain pipe interiors free of dirt and debris. Close open ends of pipe by acceptable methods (duct tape ends) when pipe installation is not in progress.
 8. All pipe routed through sleeves will be banded with a steel banding tool to wooden blocks to prevent vibration of the pipe inside of sleeve.
3. Sprinklers, fittings, valves, and accessories:
1. Install fittings, valves, sprinkler heads, risers, and accessories in accordance with manufacturer's instructions, except as otherwise indicated.
 2. Set sprinkler heads perpendicular to finished grades, except as otherwise indicated.
 3. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distances indicated.

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4. Reconnect controller, if required, in accordance with manufacturer's written instructions. Install valve access boxes on a suitable base of bricks to provide a level foundation at proper grade and to provide drainage of the access box. 1 cubic feet of pea gravel below box to be provided for drainage.
 5. Automatic valves shall be installed plumb with valve access box with all valve handles, bolts, connections and electrical splices accessible through the valves box opening (not less than 6" below valve box cover).
 6. All seal threaded connections of control valves with Teflon tape. **Plastic joint type compound is not acceptable.**
4. Control wiring:
1. Install electric control cable in the piping trenches wherever possible. Place wire in trench adjacent to pipe. Install wire with slack to allow for thermal expansion and contraction. Expansion joints in wire may be provided at 200-foot intervals. Where necessary to run wire in a separate trench, provide a minimum cover of 15". Wire cannot be plowed or pulled with a vibratory plow.
 2. Provide sufficient slack at site connections at remote control valves in control boxes and at all wire splices to allow raising the valve bonnet or splice to the surface without disconnecting the wires when repair is required.
 3. Connect each remote control valve to one station of a controller except as otherwise indicated.
 4. Connect remote control valves for each controller to a common ground wire system, independent of all other controllers.
 5. Make wire connections to remote control electric valves and splices of wire in the field, using water proof wire connectors and sealing cement in accordance with manufacturer's recommendations, dry splices will not be accepted. Make wire splices in accessible splice or valve boxes 10" in diameter or greater.
 6. Provide tight joints to prevent leakage of water and corrosion build-up on the joint.
 7. When control wiring is in common trench with main line, wiring shall be below main line with 4" of fill dirt between pipe and wire.
 8. Above-ground wire is to be installed in conduit and/or in accordance with electrical codes.
 9. All materials and methods of installation shall conform to local electrical codes.
5. Flushing, testing, and adjustment
1. After sprinkler piping and risers are installed and before sprinkler heads are installed, open control valves and flush out the system with full head of water.

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2. Perform system testing upon completion of each section. Make necessary repairs and retest repaired sections as required.
 3. Adjust sprinklers after installation for proper and adequate distribution of the water over the coverage pattern. Adjust for the proper arc of coverage.
 4. Adjust all electric remote control valve flow control stems for system balance. Contractor must set pressure regulating valves prior to acceptance specification on design.
 5. Test and demonstrate the controller by operating all programs, day, hour, and station selection features as required to automatically start and shut down irrigation cycles to accommodate plant requirements and weather conditions.
6. Service:
1. When requested, return to the site during the subsequent fall season and winterize the system. Drain all water from the system and blow out the system with compressed air.
 2. When requested, return to the site during the subsequent spring season and demonstrate to the Owner Representative the proper procedures for the system start-up, operation, and maintenance.
 3. After 3 months of continuous operation, after acceptance of job, contractor must return to the site and re-adjust all irrigation heads, by re-packing heads that have become dislodged due to resettling of ground, torque of spray, or vibration. Re-adjust radius, arc, and trajectory of spray of all heads.

3.4 DISPOSAL OF WASTE MATERIAL

1. Stockpile, haul from site, and legally dispose of waste materials, including unsuitable excavated materials, rock, trash, and debris.

3.5 ACCEPTANCE

1. Test and demonstrate to the Owner the satisfactory operation of the system free of leaks.
2. Instruct the Owner's designated personnel in the operation of the system including adjustment of sprinklers, controller(s), valves, and pump controls.
3. Upon acceptance, the Owner will assume operation of the system.

3.6 GUARANTEE

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1. The contractor shall guarantee all workmanship covered by the specifications to be free of defects for a period of one (1) year from the date of final acceptance of the project. He shall replace any part or parts found to be defective within the period of guarantee at no cost to the owner, except repairs or replacement necessitated by damage by others.
2. Back filling of all excavation shall be guaranteed. If, at any time during the first year of the guarantee period, trenches or heads should settle, the irrigation contractor shall repair any settling at no cost to the owner.

3.7 CLEANING

1. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from irrigation system installation.

END OF SECTION 327000

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SECTION 32 92 00 - LAWNS AND GRASSES

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:
 - 1. Seeding.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for excavation, filling and backfilling, and rough grading.
 - 2. Division 2 Section "Trees, Shrubs and Groundcovers" for exterior plants.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- C. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for turfgrass sod, identifying source, including name and telephone number of supplier.

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- C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- D. Qualification Data: For landscape Installer.
- E. Soil Test Reports: For amended planting soil.
- F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Planting Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

1.7 SCHEDULING

- A. Planting Periods: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 1—May 15
 - 2. Fall Planting: September 15—December 1
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

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1.8 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
 - 1. Seeded Lawns: 60 days from date of Substantial Completion.
- B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow grass 2 to 3 inches high.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species Mixture of turf type Tall Fescue & Heat Tolerant Bluegrass
 - 1. Turf-type Tall Fescue seed shall make up 90%, by weight, of the seed mix. Provide a mixture of at least three of the varieties listed below, with no more than 40%, by weight, of any single variety being included in the mix.
 - 2. Approved Varieties: Apache III, Biltmore Bingo, Cochise III, Chapel Hill, Constitution, Coyote 11, endeavor, Expedition, Justice, Matador, Ninja 2, Olympic Gold, Penn 1901, Rebel Exeda, Rebel 2000, Renegade, Tarheel and Wolfpack or other varieties approved by architect.
 - 3. Heat Tolerant Bluegrass shall make up 10%, by weight, of the seed mix. Acceptable varieties include Thermal Blue, Thermal Blue Blaze, Solar Green and Dura Blue.
- C. Seed shall be mixed by dealer. Submit dealer's guaranteed statement of composition, mixture and percentage of purity and germination of each variety to the Architect.

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2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: Class O, with a minimum 95 percent passing through No. 8 (2.36-mm) sieve and a minimum 55 percent passing through No. 60 (0.25-mm) sieve.
 - 2. Provide lime in form of dolomitic limestone.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

2.3 FERTILIZER

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.4 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.5 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long. Install on restored areas of stadium berms.
- B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long. Install on restored areas of stadium berms.

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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Planting soil: Remove stones and debris from subgrade that might interfere with grading or later tillage operations. Sod or other cover that cannot be disked or otherwise incorporated into the planting soil so that topsoil can be spread properly shall be removed.
- C. Apply commercial fertilizer at a rate of 7 lbs. per 1000 sf. Fully and completely incorporate amendments into the top 6 inches of soil.
- D. Applying Inorganic Amendments: Apply inorganic amendments at the rate established by testing agency.
- E. Fully and completely incorporate fertilizer and inorganic amendments into the top 6 inches of soil, creating an eight-inch thick section of amended planting soil
- F. Fine Grading: Previously established grades shall be maintained on the areas to be treated in a true and even Condition; necessary repairs shall be made to previously graded areas. Where grades have not become established, the areas shall be graded as shown, and all surfaces shall be left in an even and properly compacted condition to prevent formation of depressions. Finished grade shall be such that after subsequent treatments, i.e. tillage, and planting, the planted grade will be flush with adjoining surfaced grade of paved areas. After natural settlement and light rolling, the completed work shall conform to the lines, grades, and elevations shown on the plans. Limit fine grading to areas that can be planted in the immediate future.

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- G. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- H. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with nonasphaltic tackifier.
 - 2. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry application at a minimum rate of 500-lb/acre (5.1-kg/92.9 sq. m) dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 lb/acre (10.2 kg/92.9 sq. m).

3.5 SATISFACTORY LAWNS

- A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches .
- B. Re-establish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.6 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- C. Remove erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

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SECTION 32 93 00 – TREES, SHRUBS AND GROUNDCOVERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Furnish all labor, materials, equipment and incidentals for furnishing, installing and maintaining landscape plantings and any other incidental items necessary for satisfactory completion of all work as shown on the Drawings and in Specifications.

1.2 QUALITY ASSURANCE

A. Quality Assurance Standards

1. All plant material shall conform to the current issue of the American Standard for Nursery Stock published by the American Association of Nurserymen (ANSI Z60.1)
2. Reference Codes and Standards:
 - a. American Standard for Nursery Stock ANSI Z60.1
 - b. Bailey's Standard Cyclopedia of Horticulture
 - c. Standardized Plant Names, American Joint Committee on Horticultural Nomenclature (AJCHN)
 - d. Hortus III
3. Source Quality Control:
 - a. Packaged products shall indicate the manufacturer's guaranteed analysis on each package and arrive on site as originally packaged and unopened.
 - b. For freshly dug plants, use nursery grown stock or, if specified, field grown stock, acclimated to the soil and climatic conditions in the local area of intended planting.
 - c. The Contractor shall submit to the Architect the names and locations of nurseries which he proposes to use as sources of acceptable plant material. The Contractor shall personally inspect all nursery materials to determine that the materials meet the requirements of this section. Proposed materials shall be flagged at the nurseries by the Contractor prior to viewing by the Landscape Architect.
 - d. Use plants grown under good nursery practices for a period of two full growing seasons in a State certified nursery.

1.3 SUBMITTALS

- A. Samples: Samples of all materials other than plants shall be submitted for approval to the Landscape Architect.

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- B. Fertilizer, Lime and Soil Supplement Product Certification: Submit certificates certifying such products to have a guaranteed analysis in conformity with the Landscape Architect approved laboratory soil supplement recommendations report.
- C. Plant Certifications: Submit plant material certificates certifying the plants to be typical and the species or variety in conformity to the current edition of "American Standard for Nursery Stock" of the AAN.

1.4 SUBSTITUTIONS

- A. If a Contract plant is found to be unavailable, the Contractor shall notify the Landscape Architect.
- B. The Contractor shall select another equivalent, available plant and submit details to the Landscape Architect for approval.
- C. Approved substitute plants shall be of the same size, value and quality as the original plant.

1.5 UTILITIES

- A. The Contractor shall call utility companies ahead of planting to locate all utilities.
- B. If there is a conflict between the utilities and the planting pattern, the Architect must approve the Contractor's plan for specifying an alternative location for plants prior to the planting process.
- C. Should the Contractor neglect to gain approval of the Architect and proceed to install material, should there be conflicts between the planting and utilities, the Contractor shall bear the costs of relocating all material conflicting with utilities.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver packaged products to the site in unopened containers with labels intact and legible.
- B. Deliver plant materials to the site in a protected condition to prevent wind damage and drying. Plant materials exhibiting a "heated" or "sweated" condition due to tight packaging or poor ventilation are subject to rejection.
- C. Deliver plants tagged with the name and size legibly indicated in accordance with the AAN standards of practice. Provide at least one tagged plant in each bundle or lot. In all cases, botanical names shall take precedence over common names.

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- D. Store packaged products in a manner so as to prevent moisture damage and other forms of contamination.
- E. Prepare freshly dug plants for handling and shipment with balled and burlapped (B&B) root systems. Perform B&B work in accordance with AAN Standards and in accordance with ANSI Z60.1 concerning diameter and depths of balls on B&B plants. B&B plants arriving at the site with broken, loose, excessively dry or fractured balls are subject to rejection.
- F. Anti-desiccant shall be applied on all material dug in foliage.
- G. Plants damaged in handling or transportation may be rejected.

1.7 JOB CONDITIONS

- A. Environmental Requirements: Do not perform work of this Section when soil or weather conditions are unsuitable. Unsuitable conditions include soil saturated with moisture or frozen in place and precipitation of any kind present or occurring during the Work.
- B. Plant Setting Dates: The following dates shall govern except that when environmental conditions warrant, the Architect may extend the plant setting dates.
 - 1. Deciduous Trees and Shrubs: September 15 to May 30 inclusive;
 - 2. Evergreen Trees and Shrubs: Spring - March 15 to June 1 inclusive; Fall - September 15 to December 15 inclusive.
 - 3. Groundcovers and Perennials: Same as for Evergreen Trees and Shrubs.
- C. Unforeseen Contingencies: The Contractor will not be held responsible for unforeseen contingencies (other than those in 1.5 above) such as, but not limited to, rock, water, clay pan or other obstacles encountered in excavation work which are not apparent on the surface.
- D. Drainage: No plants shall be planted in situations that show obviously poor drainage. Such situations shall be brought to the attention of the Architect and, if necessary, the plants may require underdrainage.
- E. Water: Water will be supplied by Contractor.
- F. Utilities: Contractor shall note the potential minimum earth cover of buried utilities and shall be prepared to dig all tree pits and shrub beds by hand to minimize disturbances. Hand digging will not be considered as an extra and no additional payments will be made for such work.

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PART 2 - PRODUCTS

2.1 PLANT MATERIALS

- A. Plants shall conform to the varieties specified in the plant list and be true to botanical name as listed. Plants shall be in accordance with ANSI Z60.1 - 1986 except as otherwise stated in the specifications or shown on the Drawings. Where the drawings or specifications are in conflict with ANSI Z60.1 - 1986, the drawings and specifications shall prevail.
- B. Planting stock shall be well-branched and well-formed, sound, vigorous, healthy, and free from disease, sun-scald, windburn, abrasion, and harmful insects or insect eggs and shall have healthy, normal and unbroken root systems. Deciduous trees and shrubs shall be symmetrically developed, of uniform habit of growth, with straight stems and free from objectionable disfigurements. Evergreen trees shall have well developed symmetrical tops with typical spread of branches for each particular species or variety. Groundcovers and vines shall be vigorous, have the number and length of runners and clump size specified, and be the proper age for the length of runners and clump size specified. Only shrubs and groundcover plants well established in removable containers, integral containers, or formed homogeneous soil sections shall be used. Plants shall have been grown under climatic conditions similar to those in the locality of the project.
- C. The minimum acceptable sizes of all plants, measured before pruning and with branches in normal position, shall conform to the measurements indicated on the drawings. Plants larger in size than specified may be used with the approval of the Landscape Architect with no change in the contract price. If larger plants are used, the ball of earth or spread of roots shall be increased in accordance with ANSI Z60.1 - 1986.
- D. Plant material shall be nursery grown unless otherwise indicated and shall conform to the requirements and recommendations of ANSI Z60.1. Plants shall be dug and prepared for shipment in a manner that will not cause damage to branches, shape, and future development after planting.
 - 1. Balled and burlapped (B&B) plants shall have ball sizes conforming to ANSI Z60.1. Plants shall be balled with firm natural balls of soil. B&B plants shall be wrapped firmly with burlap or strong cloth and tied securely.
 - 2. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers but shall not be root bound.

2.2 ANTI-DESICCANT

- A. Anti-Desiccant: "Wilt-pruf" Nursery Specialty Products, Inc., 410 Greenwich Avenue, Greenwich, Conn. 06830, or approved equivalent.

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2.3 ORGANIC AMENDMENT

- A. Leaf Mold: Well-rotted decomposed leaf material.
- B. Peat Moss.

2.4 FERTILIZERS

- A. Commercial Fertilizers: FS 0-F-241, Type 1, of Grade noted, Level B, composite and bearing manufacturer's guaranteed statement of analysis. Unless otherwise noted or specified, use 10-6-4 meeting the following minimum requirements; 10 percent of nitrogen (50% organic by weight), 6 percent of available phosphoric acid, and 4 percent of potash.

2.5 BACKFILL MIXTURES

- A. Trees:
 - 1. One part existing soil, free of stones or other material not conducive to good plant growth.
 - 2. One part organic amendment, mixed thoroughly by volume according to the method prescribed in Section 3.

2.6 MULCH

- A. Material shall be either composted (shredded) hardwood bark, pine bark, or approved equivalent.
- B. Material shall be mulching grade, uniform in size and free of foreign matter.

2.7 STAKES AND GUYING MATERIAL FOR TREES

- A. Stakes shall be rough lumber of uniform size, 2 inches by 2 inches in section or 2 1/2 inches in diameter, pointed at one end with the slope of the point back about 6 inches from the end.
- B. Guying cable shall be galvanized steel, 9-gauge wire.
- C. Hose shall be high quality braided rubber or plastic hose, 3/4 in. diameter and suitable length, black in color.

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2.8 WATER

- A. Potable--to be supplied by Owner.

PART 3 - EXECUTION

3.1 PLANTING PROCEDURES

- A. Layout of Work: Prior to digging plant pits Contractor shall layout and stake proposed locations for all plant materials. Layout shall be approved by Architect prior to installation.
- B. Test Pits: Should staked locations lie in proximity to subsurface utilities, Contractor, with approval from Architect, may perform subsurface exploration to verify utility locations.
- C. Digging Plant Pits for Trees and for Shrubs Planted as Individual Specimens:
 - 1. Excavate and reserve existing soil to depths and dimensions indicated on drawings.
 - 2. Plants shall bear the same relationship to finished grade as at the nursery. Any loose soil at the bottom of the pit shall be tamped by hand so as to inhibit settling.
 - 3. Add any amendments and/or fertilizers to reserved existing soil as specified.
 - 4. Place plants in planting pit or planting bed to proper grade and alignment indicated.
- D. Set the plants straight and in the center of the pit with the most desirable side of the plant facing toward the prominent view (sidewalk, building, street, etc.), as directed by the Landscape Architect.
- E. Plants grown in containers shall be opened as per planter's detail. Place plants in plant pit or trench, and carefully tamp planting mixture to fill voids under and around the ball, then backfill with planting mixture in 6-inch layers and settle with water.
- F. Backfilling Plant Pits for Trees and for Shrubs Planted as Individual Specimens:
 - 1. Backfill plant pit with the soil mixture specified in Section 2 of the specifications.
 - 2. Mix soil amendments prior to filling pit.
 - 3. Make sure plant remains plumb during backfilling procedure.
 - 4. Backfill sides of plant pit halfway with soil mixture and tamp as pit is being filled.

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5. Cut rope or wire from ball and remove from plant. Pull burlap back to the edge of the tree ball. Remove all plastic wraps and plastic twine.
6. Finish backfilling sides of plant pit and tamp firmly.
7. Never cover top of tree ball with soil.
8. Form a saucer above existing grade and around the outer rim of the plant pit, not above root ball, as shown on the Drawings.
9. Mulch top of root ball and saucer within 48 hours to a depth of inches 3 inches, as shown on the Drawings.
10. Water to saturation on the interior of the tree saucer until it is filled, even if it is raining. A second watering may be necessary to insure saturation of the root ball.

G. Guying:

1. Support those trees indicated on the drawings to be guyed, within three days after planting, by three guys, placed symmetrically at perimeter line of ball and to sufficient depth to hold tree rigid. Wire tree to each stake as shown on the Drawings. Protect trees at points of contact and add hose at point where wire encircles tree. Cut guying stakes so they are same level from ground after installation to a level 2 inches above the wires.

H. Anti-Dessicant Application

1. In extremely hot weather, apply anti-desiccant as directed by Architect.

I. Pruning:

1. Prune out all dead and broken branches.
2. DO NOT cut the main leader when pruning trees.
3. All cuts greater than 1/2 inch shall be carefully pared over with a sharp knife.
4. Remove all tags, labels, strings, etc. from the plants.

J. Clean-up:

1. Clean up all rubbish and debris caused by this work and remove from site. Keep site clean during maintenance period.
2. Sweep and wash surfaces soiled by this operation.

K. Final Acceptance:

1. Request inspection for final acceptance at least 10 days before completion of the Contract work and again at the end of the 12-month warranty/maintenance period.

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3.2 12-MONTH WARRANTY PERIOD

- A. During planting and for a period of twelve (12) months after completion of original planting operations, maintain plants and work incidental thereto by replanting plant replacements, watering, draining, feeding, weeding, cultivating, fertilizing, pruning, remulching, controlling insects and diseases, reguying, and by performing all other operations of care for promotion of root growth and plant life so that all work is in a satisfactory condition at the completion of the Contract and throughout the warranty period:
1. During the warranty period, replace planted trees, shrubs, hedges, and groundcover that are dead, or are in an unhealthy, unsightly, or badly impaired condition. Remove dead plants or cut off at the ground line as soon as the condition is evident. Replace season unfavorable for planting.
 2. At the conclusion of the warranty period, the Architect will make an inspection of the work to determine condition of all plants. Plants not in a healthy growing condition, as determined by the Architect, will be noted. Remove immediately and replace as soon as seasonal conditions permit with healthy plants of the same kinds and sizes as originally specified. Make such replacement in the same manner as specified for the original planting, and at no extra cost to the Owner.
 3. The Contractor will not be held responsible or liable for damage to plants and planting materials by animals, malicious or careless damage by human agencies over which he has no control, or by fire and storm damage.
- B. Warranty Procedures:
1. **Watering:** Thoroughly water plants twice each month or as required to maintain them in a healthy condition. In extremely dry periods, additional watering may be required; in abnormally wet periods, the watering may be omitted. Every two weeks during the growing season, examine each plant to determine if too much water is collecting in the plant hole. Do not overwater. If the excess water condition prevails, recommend provisions in a report to the Landscape Architect to permanently drain the plant pit. Check relative moisture content of soil for typical tree and typical area of shrub or hedge planting bi-weekly (weekly during months of July and August). Use Peerless Moisture Indicator (Tree Type) or approved equivalent, following manufacturer's recommendations. Provide sufficient water to maintain relative moisture content of 25 to 30 percent.
 2. **Weeding:** During the growing season, weed the mulched area around each plant and cultivate at least once every two weeks. Chemical weed killers may be used, subject to the approval of the Architect, but at the responsibility of the Contractor should plants be damaged. Remove weeds from the site.

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C. Warranty:

1. Contractor shall guarantee all plant material for a period of twelve (12) months after final inspection and acceptance of Contract work.
2. This inspection can be on all or partially completed work under the Contract.
3. Inspection will be made by the Architect and the landscape contractor within two weeks of written notification from the Contractor.
4. Contractor may be required to replace plants that die back beyond normal pruning lines, as determined by the Architect at no additional expense.
5. This warranty shall be limited to one replacement per plant.

END OF SECTION 32 93 00

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SECTION 220000 - PLUMBING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section of the specifications shall be applicable to all phases of plumbing work covered by specifications and drawings issued for this project.
- B. The "General Conditions of the Contract," "Supplementary General Conditions," and all other similar general requirements issued for this project shall apply to all plumbing work and are hereby made a part of this section.
- C. The Contractor and/or his representatives shall be fully acquainted with the design and operation of the systems and equipment described in these specifications and on the drawings.
- D. Work included under this section shall include complete systems as shown on the plans and as specified. Provide supervision, labor, material, equipment, machinery, plant, and other items necessary to complete the plumbing systems. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation.
- E. Definitions:
 - 1. "Owner" and "Contractor" shall mean the respective parties to the prime contract governing the project. Only one contractor is recognized as a party to this contract. Where the terms "Plumbing Contractor" or "Subcontractor" are used, it is for convenience only.
 - 2. "Architect/Engineer" shall mean the firm and authorized representatives of the firm engaged by the Owner for architectural and engineering services related to this project.
 - 3. "Plumbing" shall mean all work related to plumbing systems including sanitary and storm drainage, domestic water, gas, compressed air, fuel oil, and similar systems, including all related components, accessories, controls, and miscellaneous work required for a complete system.
 - 4. "Contract Documents" shall mean and include the agreement, the drawings and specifications and all modifications thereto authorized by the Owner in writing prior to final completion of the project.
 - a. The term "Agreement" shall mean the completed and signed contract form.
 - b. The term "Drawings" shall mean the drawings prepared by the Architect/Engineer for specific use in bidding and execution of the work.

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- c. The term "Specifications" shall include the legal and procedural documents, the general conditions, special conditions, and the technical specifications.
 - d. The term "Technical Specifications" shall mean that part of the specifications which describes, outlines, and stipulates the kind and quality of the materials to be furnished, the quality of workmanship required, and the methods to be used in the construction under the contract. For convenience, the plumbing portions of the technical specifications are arranged into one general section and several detailed sections related to the various trades represented in the work. Such arrangement and references shall not operate to make the Architect/Engineer an arbiter in establishing the limits of any subcontract or trade.
-
- 5. "Work" of the Contractor shall mean labor or materials or both.
 - 6. "As shown," "as indicated," "as detailed," or words of similar import shall mean reference to the drawings included in the contract documents, unless stated otherwise.
 - 7. "As directed," "as required," "as permitted," "approved," or words of similar import shall mean that the direction, requirement, permission, approval, or acceptance of the Architect/Engineer is intended unless stated otherwise.
 - 8. "As necessary" shall mean that which is necessary to achieve satisfactory completion of the work in order to provide the intended function and form of the project in compliance with the contract documents.
 - 9. "Provide" shall mean "provide complete and in place," that is "furnish and install," ready for beneficial occupancy by the Owner. Except where stated otherwise, description of any work in the contract documents shall mean that the work shall be provided by the Contractor, even though the words "provide" or "furnish and install" do not accompany the description.
 - 10. "Similar" shall be interpreted in a general sense and not as meaning identical, and all related details shall be worked out in respect to their location and their connection with other parts of the work.
 - 11. Exposed: Piping and equipment exposed to view in finished rooms.
 - 12. Option or Optional: Contractor's choice of an alternate material or method.
 - 13. "Sprinkler" shall mean all work related to fire suppression systems including sprinkler, standpipe, fire pump, and similar work, including all related components, accessories, controls, and miscellaneous work required for a complete system.

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1.2 INTENT OF CONTRACT DOCUMENTS

- A. The contract documents are complementary, and what is called for in one place shall be as binding as if called for in all places. Where variances occur between drawings and specifications or within either document itself, include in the contract price the item or arrangement of better quality, greater quantity, or higher cost. Agreement shall take precedence over the specifications and drawings. Figured dimensions shall be used in preference to scaling the drawings. In case of conflict between large and small scale drawings, the large scale drawings shall govern.
- B. The plumbing drawings show the general arrangement of all piping, equipment, and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. The plumbing work shall conform to the requirements shown on the plumbing drawings. Architectural and structural drawings shall take precedence over plumbing drawings. Because of the small scale of the plumbing drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, boxes, offsets, transitions, and other accessories as may be required to meet such conditions.

1.3 CODES AND STANDARDS

- A. All materials and workmanship shall comply with all applicable codes, state and federal laws, local ordinances, industry standards, utility company regulations, and all other criteria which normally apply to work of this nature.
- B. In case of difference between building codes, state laws, federal laws, local ordinances, industry standards, utility company regulations, other criteria and the contract documents, the more stringent regulations will apply. The Contractor shall promptly notify the Architect/Engineer in writing of any such difference.
- C. If the Contractor performs any work that does not comply with these contract documents or the requirements of the applicable building codes, state laws, local ordinances, industry standards, utility company regulations, and other applicable criteria, he shall bear all costs arising in correcting the deficiencies.
- D. The standards referred to, except as modified in the specifications, shall have full force and effect as though printed in these specifications. The manufacturer and trades involved shall be familiar with the application of these standards.
- E. Applicable codes and standards shall include, but are not necessarily restricted to, the most recently recognized issues of the following:

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1. Building Codes:
 - a. Virginia Uniform Statewide Building Code
 - b. International Plumbing Code and accumulative supplements.

2. Industry Standards, Codes, and Specifications:
 - a. AASHO American Association of State Highway Officials
 - b. ABA Architectural Barriers Act
 - c. ADA Americans with Disabilities Act
 - d. AGA American Gas Association
 - e. ANSI American National Standards Institute
 - f. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers
 - g. ASME American Society of Mechanical Engineers
 - h. ASPE American Society of Plumbing Engineers
 - i. ASSE American Society of Sanitary Engineering
 - j. ASTM American Society of Testing and Materials
 - k. AWS American Welding Society
 - l. CISPI Cast Iron Soil Pipe Institute
 - m. AWWA American Water Works Association
 - n. FS Federal Specification
 - o. MSS Manufacturer's Standardization Society of the Valve and Fittings Industry, Inc.
 - p. NBS National Bureau of Standards
 - q. NEC National Electrical Code
 - r. NSF National Sanitation Foundation
 - s. PDI Plumbing & Drainage Institute
 - t. UL Underwriters' Laboratories, Inc.

1.4 GOVERNMENTAL FEES, PERMITS, AND INSPECTIONS

- A. Under each applicable section of the detailed plumbing specifications, the Contractor shall obtain and pay for all required licenses, permits, charges for connections to outside services, fees and inspections. Upon completion of the work under each section of the detailed plumbing specifications, the Contractor shall furnish a certificate of final inspection to the Architect/Engineer from the governmental inspection department having jurisdiction.

1.5 VISITING THE SITE

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- A. Each Contractor shall be responsible for visiting the site before bidding the job to familiarize himself with all existing conditions to be met in the execution of the work under this contract. No additional compensation will be allowed for any changes which may be required to make because of site conditions.

1.6 QUALITY ASSURANCE

- A. Product Criteria:

1. All materials shall be new and shall bear the manufacturer's name, trade name, and the UL label in every case where a standard has been established for this particular material. The equipment to be furnished shall be essentially the standard product of a manufacturer regularly engaged in the production of the required type of equipment, and shall be the manufacturer's latest approved design. All equipment shall bear a permanent and legible factory-applied nameplate to permit identification of manufacturer, model number and type of unit.
2. Equipment Service: Products shall be supported by a service organization which maintains an adequate inventory of repair parts and is located, in the opinion of the Architect/Engineer, reasonably close to the site.
3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer to provide for uniform appearance, operation, and maintenance.
4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

- B. Manufacturers' directions shall be followed in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect/Engineer in writing of any conflict between any requirements of the contract documents and the written instructions before proceeding with the work. If the Contractor performs any work that does not comply with the manufacturers' directions or such written instructions from the Architect/Engineer, he shall bear all costs arising in correcting the deficiencies.

- C. Factory Start-up by the manufacturer's Factory Certified Representative shall be provided where required for each water heater or other equipment specified to have factory start-up. Letters signed by the Representative stating that their equipment has been started, tested, and is operating safely shall be submitted to the Owner as part of the bound Operations and Maintenance Instructions manual specified in section 2.10 CATALOG DATA FOR OWNER of this specification.

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1.7 BIDDING INSTRUCTIONS

- A. Products are generally specified by a performance specification and/or by manufacturer's name and model number or trade name.
- B. When specified only by a performance specification, the Contractor may use any manufacturer who meets the performance specification and applicable codes. (The Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS.)
- C. When several products/manufacturers are specified together, then the Contractor has the option of using any product/manufacturer listed. The Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS. The Contractor's bid shall be compiled on the use of the listed products without exception. Substitutions will only be considered after the contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS.
- D. When several products/manufacturers are specified together and the system design is based on one of the listed products by specific model number(s) or catalog number(s), then the Contractor has the option of using the one specific product or any other product/manufacturer listed. In either case, the Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS. However, when the other listed product/manufacturer is used, the Contractor shall be responsible for determining that the product(s) will be compatible with building design, electrical design, plumbing design, and the product(s) will not necessitate design modifications by the Architect/Engineer. The Contractor's bid shall be compiled on the use of the listed products without exception. Substitutions will only be considered after the Contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS. If the products/manufacturer are listed to be "only," then substitutions will not be considered.
- E. When only one manufacturer's name is listed, this shall be the basis of the bid. The Contractor's bid shall be compiled on the use of the listed product. Substitutions will only be considered after the Contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS.

1.8 SUBSTITUTIONS

- A. Substitutions will not be considered during the bid.
- B. After the Contract has been executed, the Architect/Engineer will consider a formal request for a review of substituted products in place of those specified, under the following conditions:

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1. Not later than 30 days from the Contract Date, the Contractor shall provide a list of products proposed as substitutions, including the name, manufacturer, and section of the specifications governing the product.
2. The request shall be accompanied by accurate cost data on the proposed substitutions indicating whether or not a modification of the Contract Sum is to be considered.

C. Substitutions are understood to mean that the installing Contractor:

1. Has personally investigated the proposed substitute and has determined that it is equal or superior in all respects to the item specified;
2. Will provide the same guarantee for the substitution that he would for the item or equipment specified;
3. Certifies that the cost data is complete and includes all related costs under this Contract, and waives all claims for additional cost related to the installation of the accepted substitute;
4. Has coordinated the installation of the substitute, providing design modifications and changes as required for the work to be complete in all respects;
5. Has coordinated the installation of the substitute with the General Contractor pertaining to changes required for the work to be complete with all trades and all changes shall be provided without additional cost to the Owner.

D. The acceptance by the Architect/Engineer of any or all of those substitute items listed by the Contractor for review shall not constitute an approval of the substitute but shall mean that the Contractor may then submit detailed shop drawings for review.

E. When a request for substitution is granted, shop drawings will be reviewed by the Architect/Engineer. Shop drawings not complete with proper review information will not be reviewed and will be returned unchecked. If after two submittals, the substitute equipment is not approved, the specified equipment shall be provided.

1.9 SHOP DRAWINGS

A. Shop Drawings are required for all material and equipment that is specified by a manufacturer's name or as indicated in the technical specifications. Furnish the number of copies required by the General and Special Conditions of the Contract, but in no case less than six (6) copies. Submittal data for related equipment shall be submitted at one time.

B. Substitutions will not be considered if:

1. They are indicated or implied on shop drawing submissions without information specified in 1.8 - SUBSTITUTIONS.

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2. They require a substantial revision of the Contract Documents in order to accommodate their use.
- C. Identify submittals with PROJECT NAME and NUMBER, CONTRACTOR'S NAME, SECTION NUMBER & NAME, and PARAGRAPH NUMBER of SPECIFICATION GOVERNING, MANUFACTURER, MODEL or STYLE, and CONTRACTOR'S REVIEW STAMP. Submittals shall be detailed, dimensioned drawings showing construction, size and arrangement, service clearances, performance characteristics, and capacity. Where submittals are provided that include multiple types or styles of the specified item and/or multiple options, the exact item and options being submitted shall be CLEARLY MARKED on the submittal sheet. Submittals not properly identified or containing information of a general nature will not be reviewed and will be returned unchecked.
- D. Acceptance of shop drawings shall not be considered as a guarantee of measurements or building conditions. Acceptance shall not relieve the Contractor from the responsibility or necessity of furnishing material or performing work required by the drawings and specifications. Submittal data on any one item shall not be reviewed more than three (3) times. If not accepted after the third review, the Contractor shall provide the equipment upon which the design was based.
- E. Failure to submit shop drawings in ample time for checking shall not entitle an extension of contract time, and no claim for extension by reason of such default will be allowed.
- F. No material or equipment, for which submittals are required, may be delivered to or installed at the job site until submittals have been accepted.
- G. Unless a specific finish is indicated in the contract documents, wherever a choice of finish is available for the specified item, submit accurate color chips or charts to the Architect for review and selection.

PART 2 – PRODUCTS

2.1 DRIVE GUARDS

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory fabricated unit casings.

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- B. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- C. Access for Speed Measurement: One inch diameter hole at each shaft center.
- D. Lubrication: Guards shall not interfere with lubrication of equipment.

2.2 PAINTING

- A. General - Paint plumbing equipment and material in Equipment Rooms and utility type areas and located outside of the building or on the roof. Painting of equipment and material in finished rooms or areas shall be accomplished as described in PAINTING Section of the Architectural Specifications. Painting in concealed spaces shall be limited to equipment and materials not otherwise protected from rusting such as hangers and supports. Paint shall be products of Sherwin-Williams, Pittsburgh, or Pratt-Lambert. All paints, finishes and coatings shall comply with Green Seal Standards GS-03, GS-11, and SCAQMD Rule #1113 VOC limits for paints and coatings.
- B. Workmanship - The work shall be accomplished by workmen skilled in the painting trade after testing is complete and systems are ready for operation. Surfaces to be painted shall be completely dry before applying paint. Surfaces shall not be painted when the temperature is below 50 Deg. F or above 120 Deg. F, or when they are exposed to hot sun. Materials shall be evenly spread and smoothly flowed on without runs or sags. Each coat shall be thoroughly dry before application of succeeding coat. The painters shall protect adjacent surfaces with drip covers during the process of painting. Upon completion, paint spots, if any, shall be removed from adjacent surfaces.
- C. Preparation of surface - Metal surfaces shall be cleaned with solvent before applying materials. Rust and scale shall be removed by wire brushing or sanding. Galvanized surfaces shall be pretreated with a phosphoric acid cleaning solution and primed with Sherwin-Williams "Galvanized Iron Primer."
- D. Painting - After preparation as described above, each item shall be painted as follows, except color of paint for equipment and material located outside of the building or on the roof shall be as selected by the Architect.
 - 1. Painting is not required of equipment, equipment supports, and hangers with a factory-finish coat. Patch painting is required of any damaged areas to match factory-finish coat. Painting is required where equipment or equipment supports do not have factory-finish paint. Equipment and associated hangers and supports shall be primed with one coat of alkyd, zinc potassium chromate metal primer, except insulated surfaces shall be primed with one coat Sherwin-Williams "Wall

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Primer and Sealer." Finish with two coats of Sherwin-Williams "Metalastic II-Steel Gray" Enamel. Exterior of belt guards and other protective guards shall be finished with two coats of machinery enamel in OSHA yellow color. Interior of items covered by belt guards and other protective guards shall be finished with two coats of machinery enamel in OSHA orange color. Nameplates on equipment shall not be painted.

2. Exposed pipes, conduits, and associated hangers exposed in equipment rooms and other unfinished areas such as storage areas shall have two finish coats of paint of the same color as adjacent walls or ceilings. Bare copper pipe shall not be painted. Canvas or paper jacket insulation of pipes exposed in unfinished areas shall be primed with Sherwin-Williams "Wall Primer and Sealer" before final two coats of paint. Hangers and supports in concealed areas not protected by factory-finish paint shall have one coat of Sherwin-Williams "Kromik Metal Primer."
3. All exposed gas piping and fittings, interior and exterior, shall be painted, coated or wrapped as described in Section 22 60 00 and this section as applicable.

E. Identification of pipes and equipment:

1. Equipment - Each piece of equipment shall be identified by stenciled marking that will read the same as the identification shown on plumbing drawings. Stencil letters shall be 2 inches high upper case painted with Sherwin-Williams "Metalastic II" white enamel.
2. Pipes shall be identified using pre-printed markers sized appropriately for the pipes being identified (shop drawings required). Markers shall be Seton "Setmark" type or approved equal or equivalent stencil. Pipe identification shall meet the most current edition of ANSI Specification A13.1. Apply a minimum of two complete wraps of tape at each end of pre-printed pipe markers equal to Seton Style #AR or approved equal. Markers shall be located close to valves or flanges and adjacent to changes in direction, branches and where pipes pass through walls or floors, and at maximum intervals of 15 feet on straight runs. Provide a Color Code Chart, framed with glass front, indicating piping service and color code schedule. Post in Mechanical Room where directed by Engineer.

-- OR --

2. Pipes and conduit - Color bands shall be painted on each pipe or conduit where exposed or accessible. Bands shall be 1-1/2 inches wide and shall be placed every 15 feet maximum along the pipe or conduit. Color bands shall be Sherwin-Williams "Kem Lustral" enamel as shown in the following color code schedule and chart. Provide color code chart, framed with glass front, sized appropriately for number of colors used. Post in mechanical room where directed by Engineer.
3. Color code schedule

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COLOR BANDING CODE

Number	Color	Catalog Number
1.	Orange	No. F65 E 36
2.	Blue	No. F65 L 3
3.	Brown	No. F65 N 11
4.	Red	No. F65 R 1
5.	Black	No. F65 B 1
6.	Yellow	No. F65 Y 48
7.	Green	No. F65 G 40

- 4. Pipe shall be identified with flow arrows as described below
 - a. Arrows shall be stencil type.
 - b. Arrows shall be readable from floor.
 - c. Arrows shall be installed every 15'-0" maximum.
 - d. Arrows shall be painted on pipes.

F. Identification of Valves: Properly mark service and control valves. Valve markers shall be metal tags with designations stamped thereon or laminated engraved plastic chained with jack chains (not beaded chains) to their respective valves. Identification symbols or designations shall be the same as shown on the Contract Documents.

G. Equipment locations above acoustic tile ceilings: Provide colored brass push-pins complete with a minimum 1/2" shank and 5/8" diameter head. Pin head color shall be blue or color as selected by Architect or Owner. Locate push-pins directly below all scheduled plumbing equipment.

2.3 MOTORS, CONTROL, AND ELECTRICAL WIRING

A. Provide motors in accordance with NEMA Standards and suitably designed to match the starting and running characteristics of the driven equipment. Unless indicated otherwise, motors less than 1/2 horsepower shall be wound for 120 volt, single phase, 60 hertz. Motors 1/2 horsepower and above, unless indicated otherwise, shall be wound for three phase, 60 hertz, 200 volt, 230 volt, or 460 volt as required by the system voltage. Select motors coordinated with the utilization voltage and phase. Motors for equipment with VFD shall be matched to the VFD.

B. All starters and safety switches, except for those specified to be furnished with the plumbing equipment, shall be furnished as part of the Electrical Work - Division 26.

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- C. Starters and safety switches furnished with the plumbing equipment shall comply with the specifications of Division 26. Starters furnished as an integral part of the plumbing equipment shall be complete with properly sized overload heaters. Integral 3-phase motor starters and VFD's shall be provided with phase loss relay as specified in Division 26.
- D. Domestic water temperature control wiring, equipment control wiring, and interlock wiring necessary for the proper sequence of operation of plumbing equipment shall be furnished as part of the Plumbing Work, [Section 22 33 00 - DOMESTIC WATER HEATERS] [and [Section 22 11 23 - PLUMBING PUMPS]]. Control wiring is any wiring, regardless of voltage, related to plumbing equipment that is not the equipment power circuit from the circuit breaker in the panelboard to the motor starter or safety disconnect switch and to the motor or equipment junction box. Where control devices (On-Off switch, Aquastat, etc.) that are intended to interrupt the motor or equipment power circuit are provided by the Plumbing Contractor and are mounted other than on or directly adjacent to the controlled equipment, the Plumbing Contractor shall provide wiring through these devices regardless of voltage or phases. All wiring shall conform to applicable sections of Divisions 26, 27, and 28 of the specifications. All low voltage control wiring in inaccessible areas or in exposed areas shall be in metal conduit and shall comply with the specifications of Divisions 26, 27, and 28. All low voltage control wiring in unexposed, accessible areas shall be wire in conduit or U.L. approved plenum rated cable supported from the structure with ties spaced 3'-0" on center. All 120 volt wiring shall be wire in conduit and shall comply with the specifications of Divisions 26, 27, and 28 of the specifications.
- E. All equipment that has electrical connections shall have wiring terminals/connectors rated for not less than 75 deg. C. If terminals/connectors are provided that are rated for less than 75 deg. C., the mechanical contractor shall incur all costs associated with upsizing wire and conduit as required by the National Electrical Code.

2.4 FIRE-STOPPING

- A. Pipe penetrations of rated walls, floors, and floor-ceiling assemblies shall be constructed in accordance with Underwriter's Laboratories, Inc., Fire Resistance Directory, Volume II, Hourly Ratings for Through Firestop Penetrations. The Contractor shall provide U.L. firestop penetrations according to the particular wall, floor, or floor-ceiling assembly rating, construction type, pipe material, pipe size, insulation requirements, sleeve requirements, and the contractor's choice of firestop products as listed by U.L. Refer to the architectural drawings for the wall, floor, or floor-ceiling assembly construction types and ratings.

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2.5 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Under each applicable section of the detailed plumbing specifications, the Contractor shall furnish and install all accessories, connections, bases, guards, supports, and incidental items necessary to fully complete the work, ready for use, occupancy, and operation by the Owner.
- B. Type Numbers Specified: MSS SP-58; for selection and application, MSS SP-69. Refer to Division 05, METALS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
 - 1. Concrete Insert: MSS SP-69, Type 18
 - 2. Self-Drilling Expansion Shields and Machine Bolt Expansion Anchors: Fed. Spec. FF-S-325, permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-235.
 - 3. Power-Driven Fasteners: Permitted in existing concrete or masonry not less than four inches thick when approved by the Architect/ Engineer for each job condition. Use fasteners capable of supporting a 1000 pound test load, with the actual load not exceeding 50 pounds.
- D. For Attachment to Steel Construction; MSS SP-69:
 - 1. Welded Attachment: Type 22.
 - 2. Beam Clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 7/8-inch outside diameter.
- E. Attachment to Metal Pan or Deck: As required for materials specified in Division 05 - METALS.
- F. For Attachment to Wood Construction: Wood screws or lag bolts.
- G. Hanger Rods: Hot-rolled steel, ASTM A 36 or A 575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turnbuckles shall provide 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-1/2 inches by 1-1/2 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts. Not permitted for condensate piping, fire and sprinkler piping or chemical waste drain piping.
 - 1. Allowable Hanger Load: Manufacturers rating less 200 pounds.

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2. Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 2-inch galvanized steel bands, for insulated piping at each hanger.
- I. Pipe Hangers and Supports: Use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 00 - PLUMBING INSULATION, for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports. Provide Type 40 insulation shields at all other types of supports and hangers including those for pre-insulated piping.
1. General Types (MSS SP-69):
 - a. Standard Clevis Hanger: Type 1; provide locknut
 - b. Riser Clamps: Type 8 or 42
 - c. Wall Brackets: Types 31, 32, or 33
 - d. Saddle Support: Type 36, 37, or 38
 - e. Roller Support: Type 41, 43, or 46
 - f. Turnbuckle: Types 13 or 15
 - g. U-Bolt Clamp: Type 24
 - h. For Uninsulated Copper Tube: Material compatible for use with copper to prevent electrolysis
 - i. Supports for Plastic Piping: As recommended by the pipe manufacturer
 2. Plumbing Piping:
 - a. Sprinkler System: NFPA or Factory Mutual approved types.
 - b. Horizontal Piping: Types 1, 5, 7, 9, and 10
 - c. Chrome Plated Piping: Chrome plated supports
 - d. Hangers and Supports in Pipe Chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration, and compensate for all static and operational conditions
 - e. Blocking, Stays and Bracing: Angle iron or preformed metal channel shapes, 18 gage minimum
- J. Support hubless cast iron pipe and fittings per CISPI 301-12. Brace hubless cast iron pipe and fittings 5 inches and larger using Holdrite 117 Series No-Hub Pipe and Fitting Restraints or approved equal.
- K. Concrete Equipment Bases: Unless otherwise noted on the drawings or in the specifications, concrete pads and bases not less than 4 inches high and which project not less than 3 inches beyond the equipment on all sides shall be provided for pumps, compressors, water heaters, tank supports, and other similar floor-mounted equipment which normally requires foundations. Concrete shall conform to requirements in the concrete section of these specifications. The trade responsible for the supported

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equipment shall establish sizes and locations of the various concrete bases required and shall provide all necessary anchor bolts, together with templates for holding these bolts in position. Anchor bolts shall be placed in steel pipe sleeves to allow for adjustment, with a suitable plate at bottom end of sleeve to hold the bolt. When indicated in the drawings or detailed specifications, other floor-mounted items of equipment shall have a similar concrete base. Special vibration isolation foundations that are required are specified in the detailed specifications.

2.6 PIPE SLEEVES

- A. Locate sleeves during normal course of work. Provide sleeves for piping and conduit passing through concrete floor slabs and concrete, masonry, tile, and gypsum wall construction. Sleeves shall not be provided for piping and conduit running embedded in concrete or slab on grade, except that copper piping shall require sleeves through slabs on grade. Sleeves through structural members shall be only as directed by Architect. In interior wall, provide 1/4 inch space all around between sleeve and conduit, piping, or insulation of piping.
- B. Sleeves placed in exterior walls below grade shall be O.Z. Gedney Type 'FSK' or equal, Thunderline 'LINK SEAL', or equal sleeve assemblies sized for the pipe or conduit encountered, except for cast iron piping. Sleeve assembly shall provide watertight seal and electrical insulation to reduce cathodic reaction. When a sleeve passes through a wall below a concrete slab on grade, the sealing assembly shall be on the outside of the wall. When a sleeve passes through a wall into a crawl space or the building interior, the sealing assembly shall be in the crawl space or interior of the building. Provide sleeve assembly for copper piping through slab on grade, with sealing assembly located on interior side of floor slab. Where cast iron pipes pass through an exterior wall below grade, provide an iron-pipe sleeve two (2) pipe sizes greater than pipe passing through. Caulk between pipe and sleeve with a rubber-based compound.
- C. Where sleeves are located through fire-rated walls and floor/ceiling assemblies, provide sleeves and protect the penetration in accordance with Underwriter's Laboratories, Inc., Fire Resistance Directory, Volume II, Ratings for Through Firestop Penetrations.
- D. Sleeves in mechanical rooms with floor drains or hose bibbs shall extend 4 inches above floor. Provide flanges or flashing rings with sleeves in floors with waterproof membrane and clamp or flash into the membrane. Provide sleeves flush with floor in other rooms.
- E. Sleeves shall be constructed of 20 gage galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated.

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- F. Fasten sleeves securely in floors or walls so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials from being forced into the space between pipe and sleeve during construction.
- G. All penetrations through exterior walls shall be sealed. Caulk above grade penetrations with a rubber-based compound.

2.7 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with setscrew for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes, and cover the entire pipe sleeve projection. Escutcheons for sprinkler heads shall be threaded.
- B. Thickness: Not less than 3/32-inch for floor plates. For wall and ceiling plates, not less than 0.025 for up to 3-inch pipe, 0.035 for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, except mechanical rooms.

2.8 ACCESS PANELS

- A. Under each applicable section of the detailed plumbing specifications, the Contractor shall provide access panels in all locations where required for access to concealed valves, traps, air cushions, controls, and any other equipment or materials requiring inspection or maintenance. Access panels shall be of adequate size and properly located so that concealed items will be readily accessible for servicing or for removing and replacing if necessary, except as indicated or specified otherwise. Access panels are not required in ceilings formed of removable acoustical panels.
- B. Access panels that are not fire-rated shall be Milcor or equal. Provide modular-sized access panels in inaccessible acoustic tile ceilings sized according to the tile size. Provide Milcor metal access panels with cam lock, continuous hinge and mounting trim to match finish encountered. Provide natural anodized aluminum finish for panels in kitchens and toilets. Provide prime finished steel for panels in other areas. Paint panels in finished areas to match finish surface.
- C. Where indicated and where access panels are installed in walls of shafts that are not sealed at each floor, access panels shall be Milcor or equal "Fire-Rated" and shall bear the Underwriters' Laboratories, Inc. Class B, 1-1/2 hour label. Openings shall be framed in accordance with the access panel manufacturer's recommendations. Frames shall be

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not lighter than 16-gage steel. Panels shall be not lighter than 20-gage steel and shall be insulated sandwich type. Panels shall have a continuous hinge, self-lubricating lock, a direct action-knurled knob, and an interior latch release mechanism.

2.9 CHARTS, DIAGRAMS, AND SCHEMES

- A. Charts, diagrams, and schemes listed below shall be provided under each applicable section of the detailed plumbing specifications by the Contractor, framed under glass, and installed where shown on the drawings or directed in the field. All charts, diagrams, and schemes shall be complete, neat, clear, legible, and permanent.
- B. Valve identification chart with typewritten schedule of all valves giving their tag number, description, system served, and normal operation position.
- C. Piping schemes where required by the detailed specifications.

2.10 CATALOG DATA FOR OWNER

- A. Furnish one (1) bound copy of Catalog Data on each manufactured item of equipment used in the plumbing work, complete with index listing the products alphabetically by name, together with the names and addresses of manufacturers, sales, and service representatives. Furnish two (2) bound copies of Operating and Maintenance Instructions of each item of equipment. Catalog Data and Operating and Maintenance Instructions shall be submitted to the Engineer for review prior to transmittal to the Owner.

2.11 RECORD OF AS-BUILTS AND CONDITIONS

- A. Provide a complete set of prints of plumbing plans marked to indicate as-built conditions which are different from those shown on the original construction documents. Site as-built conditions which are different from the construction documents shall be dimensioned from building or identifiable marker. Accurate locations of all concealed utility lines, both interior and exterior shall be recorded. These drawings shall be delivered to the Architect/Engineer before being turned over to the Owner.

PART 3 – EXECUTION

3.1 INSTALLATION

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A. Coordination of Work:

1. The Contractor shall compare the plumbing drawings and specifications with the drawings and specifications of other trades, and shall report any discrepancies between them to the Architect/Engineer, and shall obtain from him written instructions for changes necessary in the plumbing work. The plumbing work shall be installed in cooperation with other trades installing interrelated work. Before installation, the Contractor shall make proper provision to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor caused by his neglect to do so shall be made by him at his own expense.
2. Anchor bolts, sleeves, inserts, and supports that may be required for the work shall be fully coordinated and compatible with the related equipment or materials. Locations shall be determined by the trade installing the related equipment or materials.
3. Slots, chases, openings, and recesses through floors, walls, ceilings, roofs, and partitions shall be located by the trades requiring them.
4. Locations of pipes, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The installing Contractors shall coordinate their work to the building structure and to other trades as directed by the General Contractor. No additional compensation or extension of completion time will be granted for extra work caused by a lack of coordination. The installing Contractor shall provide dimensions and locations of all openings, shafts, and similar items to the General Contractor for his coordination and execution. Work shall be installed as required so as not to interfere with or delay the building construction. Pipes, etc., shall be concealed above ceilings, in walls, or in floors as applicable in all areas of the building except in equipment rooms, unfinished storage rooms, or other areas specifically noted to the contrary.
 - a. Right-of-Way: Lines which pitch shall have right-of-way over those which do not pitch. For example, plumbing drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
 - b. Offsets, transitions, and changes in direction of pipes shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the drawings. The Contractor shall furnish and install all traps, drains, sanitary vents, etc., as required to affect these offsets, transitions, and changes in direction.
5. Exact locations of items such as hose bibbs, wall hydrants, fire department hose valves and other similar items in finished areas of the building and on the exterior of the building shall be coordinated with each other, the building structure, and architectural features thereof so as to be aligned with or centered on other items as

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applicable. Locations indicated on the drawings are approximate. Trades shall coordinate their work with door swings, block coursing, tile arrangement, required clearances and other similar features before establishing the location of any components. Before any related work has begun, the Architect/Engineer may direct reasonable minor changes in equipment locations with no increase in contract price to the Owner. Before roughing in conduit or pipe, verify the location of equipment to be connected.

6. Installation and Arrangement: The Contractor shall install all plumbing work to permit removal of all parts requiring periodic replacement or maintenance. The Contractor shall arrange pipes and equipment to permit ready access to valves, cocks, traps, motors, control components, and to clear the openings of swinging and overhead doors and of access panels.
7. Drawings by Contractor: When directed by the Architect/Engineer, the Contractor shall submit for review by Architect/Engineer drawings clearly showing certain portions of the plumbing work and its relation to the work of other trades before beginning shop fabrication or erection in the field.
8. Dimensions: The Contractor shall ensure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that the final installation shall suit the true intent and meaning of the drawings and specifications. If he concludes that there is insufficient space for installation or specified materials, he shall immediately notify the Architect/Engineer of the conflict and shall stop affected work until he receives instructions as to how to proceed from the Architect/Engineer.
9. Damage to Work: The Contractor is responsible for damage caused by his work or workmen. Repairing of damaged work shall be done by the Contractor as directed by the Engineer at no additional cost.
10. Connections to Existing Facilities, Piping Systems, Etc: All connections to existing facilities, piping systems, etc., shall be made as required or deemed necessary to insure the maintenance of continued operation of the above and provide the very minimum of interruption. This Contractor shall make such temporary connections as may be required to facilitate this work and to protect the existing building from damage. Any work which will in any way affect the continued operation of any existing facility shall be coordinated with the proper authorities as well as the Architect-Engineer before any service is interrupted.
11. The Contractor shall be responsible for any interruptions to existing services and shall repair any damages to existing systems caused by his operations.

B. Protection and Cleaning:

1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items, in the opinion of the Architect/Engineer, shall be replaced.

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2. All items subject to moisture damage (such as controls and electrical equipment) shall be stored in dry, heated spaces.
 3. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical or mechanical injury. Clean plumbing equipment to remove dust, oil, dirt, plaster, mortar, trash, or paint. Piping and conduit shall be blown out or flushed of all foreign matter before wires are pulled in or before connections are made to equipment or systems. ****(Clean each boiler in accordance with manufacturer's instructions before connecting to the system.)****
- C. Protection of Electrical Equipment: Plumbing and sprinkler piping shall NOT be installed directly over electrical panelboards, switchboards or motor control centers, unless the pipe is a minimum of 6 feet above the electrical equipment or above a structural ceiling (concrete cap or similar). If compliance with this requirement is not possible, notify the engineer immediately. If the piping is directly above and at least 6 feet above the electrical equipment, provide a galvanized steel drain pan installed directly under the piping. Drain pan shall have minimum 2 inch high sides with a drain pipe connection at the lowest point and shall be full width of the electrical equipment being protected. Extend drain pipe to exterior or to nearest floor drain.
- D. Concrete and Grout: Use concrete and shrink compensating grout 3000 psi minimum.
- E. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- F. Work in Existing Building:
1. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills will be permitted only with approval of the Architect/Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Architect/Engineer's approval, carefully cut opening through construction not larger than is absolutely necessary for the required installation.
 2. Remove existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work or any ducts, plumbing, steam, gas or electric work without approval of Architect/Engineer. Existing work (walls, ceilings, partitions, floors, mechanical, and electrical work)

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disturbed or removed as a result of performing required new work shall be patched, repaired, reinstalled, replaced with new work, and refinished and left in as good condition as existed before commencing work. Existing work to be altered or extended that is found to be defective in any way shall be reported to the Architect/Engineer before it is disturbed. Materials and workmanship used in restoring work shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.

3. Continuity of service shall be maintained to all existing systems, except for designated short intervals during which connections are to be made. Interruptions shall be coordinated with the Owner as to the time and duration.
4. Upon completion of contract, deliver work complete and undamaged. Damage that is caused by Contractor or Contractor's workmen to existing structures, grounds, or utilities or to work done by others shall be repaired by Contractor and left in as good condition as existed prior to damaging.
 - a. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cable, etc., of utility services or of fire protection system and communications systems (except telephone) which are not scheduled for discontinuance or abandonment.
 - b. Restoration work required by damage to telephone systems shall be done by telephone company at Contractor's expense.

3.2 GENERAL PIPING INSTALLATION

- A. Under each applicable section of the detailed plumbing specifications, the Contractor shall furnish and install as shown on the drawings or as necessary to complete the working system in accordance with the intent of the drawings and specifications, a complete system of piping, valves, supports, anchors, sleeves, and all other appurtenances. The piping drawings are diagrammatic and indicate the general location and connections. The piping may have to be offset, lowered, or raised as required or as directed at the site. This does not relieve the Contractor of responsibility for the proper erection of systems of piping in every respect suitable for the work intended as described in the specifications and as approved by the Architect/Engineer. Wherever two dissimilar metals join in any piping system, install a dielectric fitting at their intersection.
- B. Erection: Piping shall be properly supported and adequate provisions shall be made for expansion, contraction, slope, and anchorage without damage to joints or hangers. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate piping installation will not be

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permitted without written approval. Pipe extending through the roof shall be properly flashed. All changes in direction shall be made with fittings. Wherever pipe hanger bears directly on the pipe being supported, the hanger shall be of the same material as the pipe.

- C. Arrangement: All piping shall be arranged so as not to interfere with removal of other equipment or devices nor to block access to doors, windows, manholes, or other access openings. Piping shall be arranged so as to facilitate removal of tube bundles. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. Piping shall be placed and installed so that there will be no interference with the installation of the equipment, ducts, etc. All piping shall be installed to ensure noiseless circulation. All piping shall be erected and pitched to ensure proper drainage. Piping shall be installed so as to avoid liquid or air pockets throughout the work. Pipe in finished areas shall be concealed. Install piping generally parallel to walls and column centerlines, unless shown otherwise on the drawings. Space piping, including insulation, to provide one inch minimum clearance between adjacent piping or other surface. Pipe shall be installed to permit free expansion and contraction without damage to joints or hangers. Exposed piping shall be installed in practical alignment with the building. All valves and specialties shall be placed to permit easy operation and access, and all valves shall be regulated, packed, and glands adjusted at the completion of the work before final acceptance. Water pipes shall not be installed in attic spaces, crawl spaces, exterior walls or similar areas which are subject to freezing, unless indicated to be heat traced.
- D. Installation of Underground Pipe: Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with adjoining pipe and to prevent sudden offsets to flow line. As work progresses, the interior of the pipe shall be cleared of dirt and superfluous materials of every description. Where cleaning after laying is difficult because of small pipe size, a suitable swag or drag shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. Trenches shall be kept free from water until pipe jointing material has set. Pipe shall not be laid when the condition of the trench or weather is unsuitable for such work. At all times when work is not in progress, all open ends of pipe and fittings shall be securely closed so that no water, earth, or other substance will enter the pipe or fittings.

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3.3 PIPE AND EQUIPMENT SUPPORTS

- A. Supports: The Contractor shall support plumb, rigid, and true to line all work and equipment furnished under each section of these specifications. The Contractor shall study thoroughly all general, structural, and plumbing drawings, shop drawings, and catalog data to determine how equipment, fixtures, piping, ductwork, etc., are to be supported, mounted, or suspended, and shall provide extra steel bolts, inserts, pipe stands, brackets and accessories for proper support, whether or not shown on the drawings. When directed, the Contractor shall submit drawings showing supports for review by the Architect/Engineer.
- B. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Architect/Engineer.
- C. Use of chain, wire or strap hangers; wood for blocking stays or bracing; or hangers suspended from piping above will not be permitted. If products are rusty, replace or thoroughly clean and coat with prime paint.
- D. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 2-inch clearance between pipe or pipe covering and adjacent work. Pipe hanger rods shall be attached to the top chord only on steel joists and beams by joist or beam clamps, without welding. Where clamps cannot be attached to the top chord of joists or beams, trapeze hangers shall be provided.
- E. Horizontal Pipe Support Spacing:
 - 1. Cast Iron: Five feet on centers maximum spacing. At least one hanger on each full length of pipe, close to hub where possible and at least one within 24 inches of each fitting, and wherever else required to prevent tendency toward deflection due to load. Provide a hanger at upper angle at each drop. Locate hangers adjacent to hubs on multiple fittings not more than four feet on centers.
 - 2. Plastic and Glass Pipe: Support in accordance with manufacturer's recommendations.
 - 3. For support spacing of all other horizontal piping, refer to MSS SP-69 and provide additional supports at valves, strainers, inline pumps and other heavy components. Provide a support within one foot of each elbow.
- F. Vertical Pipe Supports--Cast Iron Stacks: Base of stacks shall be supported on concrete, brick in cement mortar, or metal brackets permanently attached to building structure. Support stacks on each building floor structure, but not to exceed 15 feet spacing.

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- G. Connections: All piping connecting to pumps and other equipment shall be installed without strain at the piping connection. The Contractor shall be required as directed to remove the bolts in flanged connections or to disconnect piping to demonstrate that piping has been so connected.

3.4 MOTOR AND DRIVE ALIGNMENT

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- B. Direct-Connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

3.5 EXCAVATION AND TRENCHING

- A. Under each applicable section of the detailed plumbing specifications, the Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. No extras will be allowed for rock unless indicated otherwise. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and wasted as indicated on the drawings or as directed by the Architect/Engineer. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved method. Such sheeting and shoring shall be done as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if, in the opinion of the Architect/Engineer, the pipe can be safely and properly installed and backfill can be properly tamped in such tunnel sections.
- B. Trench Excavations (Includes under building and 5 feet outside of building): Trenches shall be of necessary width for the proper laying of the pipe or duct, and the banks shall be as nearly vertical as practicable. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length. Except where rock is encountered, care shall be taken not to excavate below the depths indicated. Where rock excavations are required, the rock shall be excavated to a minimum over depth of 4 inches below the trench depths indicated on the drawings or specified. Over-depths in the rock excavation and authorized over depths shall be backfilled with loose, granular,

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moist earth, thoroughly tamped. When corrosive material or unstable soil or material that is incapable of supporting the pipe is encountered in the bottom of the trench, the Contractor shall promptly notify the Architect/Engineer. Such unsuitable soil or material shall be removed to a depth as directed by Architect/Engineer and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable backfill material, as directed by the Architect/Engineer.

- C. Sanitary Sewers, Storm Sewers, and Water Mains: The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall be between 6 and 12 inches on either side of the pipe. The width of the trench above that level may be as wide as necessary for sheeting and bracing and the proper performance of the work. The bottom of the trench shall be rounded so that at least the bottom quadrant of the pipe shall rest firmly on undisturbed soil for as much of the full length of the barrel as proper jointing operations will permit. This part of the excavation shall be done manually only a few feet in advance of the pipe laying by men skilled in this type of work.
- D. Protection of Existing Utilities: Existing utility lines to be retained that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation, as well as all utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor, at his expense.

3.6 BACKFILLING OF TRENCHES

- A. Trenches shall not be backfilled until all required pressure and other tests and inspections have been performed and until the utilities systems as installed conform to the requirements of the drawings and specifications. Trenches for piping shall be carefully backfilled with materials consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials saved from the excavation or borrowed as required. The backfill materials shall be granular in nature and shall not contain coal, dust, cinders, ashes, roots, sod, rubbish, corrosive materials, large clods of earth, or stones over 2-inch maximum dimension. The Architect/Engineer may reject any on-site or borrowed materials which he considers unsuitable for the intended use of the fill.
- B. Controlled compacted backfill shall be used under slabs-on-grade, building structure, concrete paving, asphaltic concrete paving, driveway, parking areas, and other areas so specified or indicated on the drawings. All backfill required to raise the surface to the desired subgrade shall be continuously controlled and placed in maximum of 8-inch loosely placed lifts and compacted to 100 percent maximum dry density beneath the building and 95 percent under all paved drives and parking areas in accordance with ASTM D 698 (Standard Proctor). The soils engineer shall check each lift and submit reports to the Architect/Engineer in accordance with Division 31 - Earthwork.

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- C. Normal Backfill: Where controlled compacted backfill is not required, such as grassed areas, the trenches shall be carefully backfilled with material in eight-inch layers and thoroughly and carefully rammed until cover is not less than one foot. The remainder of the backfill material shall then be carefully placed in the trench in one-foot layers and tamped. The surface shall be graded to a reasonable uniformity and the mounding over trenches left in a uniform and neat condition as approved by the Architect/Engineer.
- D. Test for Displacement of Sewers: Storm and sanitary sewer mains shall be checked by the Contractor to determine whether any displacement of the pipe has occurred after the trench has been backfilled to two feet or more above the pipe. A light shall be flashed between manhole locations and through each straight section of pipe. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, or any other defects, in the opinion of the Architect/Engineer, such defects shall be remedied by the Contractor at his expense.
- E. Plants, turf, and surfacing that are to remain in the area of the excavation shall be carefully removed and placed where they will not be damaged. After the excavations are filled, the plants, turf, and surfacing shall be replaced as directed. Provide repairs for sidewalks, driveways, and other cement and asphalt surfaces which are damaged during excavating to match the adjacent work in material and finish.

3.7 CUTTING AND PATCHING

- A. The Contractor shall be responsible for all required digging, cutting, etc., incident to the work, and shall thereafter make all required repairs necessary to restore the cut structure or material to the condition existing prior to the cutting. In no case shall the Contractor cut into any major structural element, beam, or column without the written approval of the Architect/Engineer. All cutting, patching, repairing, or replacing of work required because of fault, error, tardiness, or damage by any trade shall be performed with no increase in the contract price to the Owner.
- B. Patch and repair roof in accordance with requirements of existing roof warranties and manufacturer's standard approved details.

3.8 LUBRICATION

- A. Under each applicable section of the detailed plumbing specifications, the Contractor shall provide all oil and grease required for the operation of all equipment until acceptance by the Owner. The type and application of all lubricants shall conform to the recommendations of the manufacturer of the equipment involved. The Contractor shall be held responsible for all damage to bearings while the equipment is being

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operated by him up to the date of acceptance of the project. This Contractor shall be required to protect all bearings during installation and shall thoroughly grease or otherwise protect steel shafts and other bare ferrous parts to prevent corrosion. All equipment shall be provided with covers as necessary for proper protection against damage or deterioration during construction.

3.9 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified under each applicable section of the detailed plumbing specifications, and submit the test reports and records to the Architect/Engineer.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Owner.

3.10 QUIET OPERATION AND VIBRATION

- A. Systems shall operate under conditions of load without unusual or excessive noise or vibration. Unusual or excessive noise or vibration shall be corrected.

3.11 INSTRUCTIONS TO OWNER'S PERSONNEL

- A. Under each applicable section of the detailed plumbing specifications, the Contractor shall instruct the representative of the Owner in the proper operation and maintenance of all elements of the plumbing systems. A competent representative of the Contractor shall spend not less than two days in such formal instruction and shall spend such additional time as directed by the Architect/Engineer to fully prepare the Owner to operate and maintain the plumbing systems. The Contractor shall provide letter of instruction upon completion to the Architect/Engineer stating the date of instruction and the names of those in attendance.

3.12 GUARANTEE

- A. All plumbing equipment, materials, and labor required by the contract documents for this project shall be guaranteed to be free of defective materials or workmanship for a period of one year after final acceptance of the project. Defects in equipment, materials, or workmanship occurring during this period shall be corrected with new equipment and materials or additional labor at no cost to the Owner.

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3.13 SITE VISIT REPORT

- A. Answer in writing each item of discrepancy noted on all site visit reports.

3.14 DEMOLITION

- A. Contractor shall visit the site before bidding to determine the extent and location of demolition to be performed.
- B. Contractor to remove all pipes, equipment, etc. not required, reused or needed for reconnecting to the new systems. All items not required for the new system shall be removed.
- C. The Owner shall select and retain such existing items indicated or required to be removed as he desires. Items selected by the Owner to be retained shall be removed and relocated to an Owner designated location by the Contractor.
- D. All equipment, piping, conduit, etc. to remain and be reused shall be protected from damage. Any damage to existing material shall be repaired to original condition.
- E. Coordinate all demolition activities with the phasing of construction. Demolition shall not affect operations of the building.

3.15 PHASING OF WORK

- A. The mechanical contractor is required to fully understand the phasing of work and to coordinate his work according to phasing plan drawings and related sections of the specifications.
- B. Sections of the existing building will continue to be occupied during renovation. The contractor shall be responsible for retaining existing plumbing systems to serve the occupied sections of the building. Otherwise, the contractor shall provide interim plumbing systems for the occupied sections of the building.
- C. The contractor is cautioned to fully understand the need to operate plumbing systems during construction.
- D. Provide temporary plumbing to protect the owner's property from freeze damage and from high humidity. For new construction, provide plumbing for proper drying and application of finishes.

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- E. Portions of the renovated building will be reoccupied as sections of renovation become complete. The contractor shall be responsible for providing plumbing for the reoccupied sections of building.

END OF SECTION 220000

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SECTION 220700 - PLUMBING INSULATION

PART 1 – GENERAL

1.1 CONDITIONS

- A. The applicable provisions of Section 220000, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section, and the Contractor is cautioned to read Section 220000 carefully as items of work applicable to this section are included in Section 220000.

1.2 DESCRIPTION OF WORK

- A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.
- C. In general, the work included under this section consists of, but is not limited to, the following:
 - 1. Field applied insulation for thermal efficiency and condensation control for plumbing piping and equipment.

1.3 RELATED WORK

- A. Section 220000, PLUMBING GENERAL REQUIREMENTS.
- B. Section 221100, FACILITY WATER DISTRIBUTION.
- C. Section 221300, DRAINAGE SYSTEMS.

1.4 SUBMITTALS

- A. In accordance with Section 220000, PLUMBING GENERAL REQUIREMENTS, furnish the following:

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1. Manufacturer's Literature and Dimension Cuts:
 - a. Insulation Materials: Each type used. State surface burning characteristics and thermal properties.
 - b. Insulation Facings and Jackets: Each type used. State vapor barrier properties. State that white finish will be furnished for exposed pipe and equipment.
 - c. Insulation Accessory Materials: Each type used.
 - d. Manufacturer's installation and fitting fabrication instructions for elastomeric unicellular insulation.
 - e. Make reference to applicable specification paragraph numbers for coordination.

1.5 DEFINITIONS

- A. Cold: Equipment or piping handling media at design temperature of 60 Deg. F. or below.
- B. Hot: Equipment or piping handling media above 105 Deg. F.
- C. PCF: Density, pounds per cubic foot.
- D. Runout: Branch pipe connection up to one inch nominal size and not over 12 feet in length.
- E. Thermal Conductance: Heat flow rate through materials.
 1. Flat Surface: BTU per hour per square foot.
 2. Pipe or Cylinder: BTU per hour per linear foot.
- F. Thermal Conductivity (k): $(\text{BTU} \times \text{inch thickness}) / (\text{hour} \times \text{square foot} \times \text{degree Fahrenheit temperature difference})$.
- G. Finished Spaces: Spaces used for habitation or occupancy where rough surfaces are plastered, paneled, or otherwise treated to provide a pleasing appearance.
- H. Unfinished Spaces: Spaces used for storage or work areas where appearance is not a factor, unexcavated spaces, crawl spaces, etc.
- I. Concealed Spaces: Spaces between a ceiling and floor construction above or between double walls or furred-in areas, pipe shafts, etc.
- J. Exposed: Open to view inside the building. For example, pipe run through a room, and not covered by other construction, is exposed.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Building characteristics of insulation materials shall comply with NFPA 90A, pertinent parts of which are noted as follows:
 - 1. Pipe insulation and coverings shall meet the requirements of NFPA 90A Sections 4-3.3.1 and 4-3.3.2 when installed in plenums or concealed spaces used as part of the air distribution system.
 - 2. In addition to NFPA, the insulation material shall not transform into a molten flaming liquid during combustion as characterized by some polyethylenes.
- B. Test Methods: ASTM E 84, UL 723, or NFPA 255.
- C. Insulation shall be Johns Manville, Owens Corning, Pittsburg Corning, or Armstrong. Trade names are used herein, unless indicated otherwise, to establish a standard of quality.
- D. Specified k factors are at 75 Deg. F. mean temperature unless stated otherwise. Where optional insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For a flat surface, thermal conductance equal thermal conductivity (k) divided by the thickness of the insulation. For runout insulation and condensation control insulation, no thickness adjustment need be made.
- E. All materials shall be compatible and suitable for service temperature and shall not contribute to corrosion or otherwise attack surfaces to which applied in either the wet or dry state.
- F. Underwriters' Laboratories, Inc. label or listing, or satisfactory certified test report from an approved testing laboratory will be required to show that surface burning characteristics for materials to be used do not exceed specified ratings.

2.2 INSULATION FACINGS AND JACKETS

- A. Fed. Spec. HH-B-100 for Vapor Barrier Types I and II:
 - 1. Puncture Test Method: ASTM D 781.
 - 2. Type I, Low Vapor Transmission (0.02 Perm Rating), Beach Puncture 50 Units: For insulating facing on exposed equipment, and for all pipe insulation jackets.

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Facings and jackets shall be white all service type (ASJ) suitable for painting without priming.

3. Type II, Medium Vapor Transmission, Beach Puncture 25 Units: Foil-Scrim-Kraft (FSK) type for concealed equipment.
4. Factory composite materials may be used provided they have been tested and certified by the manufacturer to meet Beach puncture units specified above.
5. Fire and smoke treatment of jackets and facings shall be permanent. The use of water soluble treatments is not acceptable.
6. Pipe insulation jackets shall have 1-1/2 inch minimum lap at longitudinal joints and not less than 3-inch butt strips at end joints. Facing on board, blanket and block insulation shall have 2-inch laps or 3-inch minimum butt strips. Butt strip material shall be the same as the jacket or facing. Laps and butt strips may be self-sealing type with factory applied pressure sensitive adhesive.

2.3 MINERAL FIBER INSULATION

- A. Owens-Corning Fiberglass SSL II ASJ Heavy Density Sectional Pipe Insulation, Fed. Spec. HH-I-558, Form D, Type III (Molded), Class 12, $k = 0.24$.
- B. Molded pipe fitting covering: Fed. Spec. HH-I-558, Form E. Class 16, $k = 0.26$, for temperatures up to 370 Deg. F.
- C. Insulation thickness and type for various piping systems shall be as indicated in the following table (Pipe Size/Insulation Thickness).
- D. Solar Heat Exchanger HE-1 and HE-2: Provide Owens-Corning non-flammable, emission free, 705 rigid board fiberglass insulation, ASTM 612, 6 PCF density, with white laminated kraft-aluminum foil reinforced all-service vapor barrier facing.
- E. Solar Piping: Provide UV resistant jacket.

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PIPE SIZE/INSULATION THICKNESS(1)

System	Temp. Range (°F)	Runouts < 1"	1" to < 1-1/2"	1-1/2" to < 8"	8" & above	Ins. Type (4,5,6)
Domestic Hot Water & HWR (Copper)	90-140	1.0	1.0	1.5	1.5	A
	141-200	1.5	1.5	2.0	2.0	A
Tempered Water	85-109	1.0	1.0	1.0	1.0	A
Misc.	80-89	1.0	1.0	1.0	1.0	A
Domestic Cold Water (Copper)	56-79	1.0	1.0	1.0	1.0	A
Horizontal Soil	Any	---	---	1.0	1.5	A

NOTES:

- (1) Minimum thickness for insulation listed in preceding table is based on Thermal Conductivity, 'k' not exceeding 0.27 Btu per inch/hr. x sq. ft. x Deg. F. based on Mean Temperature of 75 Deg. F. Insulation with greater Thermal Conductivity shall have increased thickness to provide same performance characteristics as specified.
- (2) A Fiberglass type insulation.

2.4 ELASTOMERIC INSULATION (COPPER)

- A. Armstrong Armaflex II pipe insulation, fed. Spec. HH-I-573 and HH-I-1751/2, K = 0.27, flame spread not over 25, smoke developed not over 50, (1/2 inch thick test material), for temperatures from -40 Deg. F to 211 Deg. F. No jacket required.

2.5 INSULATION ACCESSORY MATERIALS

- A. Insulation inserts at pipe supports:

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1. Material: Cellular glass or calcium silicate 1/2 section of insulation, same thickness as adjacent insulation.
2. Provide inserts for all insulated piping greater than 1-1/2 inch diameter. Install with metal insulation shields furnished with pipe supports, Section 22 00 00, PLUMBING GENERAL REQUIREMENTS. Minimum insert length: 10 inches for up to 3 inch pipe, 12 inches for 3 to 6 inch pipe, and 16 inches for 8 to 10 inch pipe.

B. Adhesives, Mastics, Cement:

1. Mil. Spec. MIL-A-3316B, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
2. Mil. Spec. MIL-A-3316B, Class 2: Adhesive for laps for adhering insulation to metal surfaces.
3. Mil. Spec. MIL-A-24179A, Type II, Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
4. Mil. Spec. MIL-B-19565B, Type 1 or Type II: Vapor barrier compound for indoor use.
5. Fed. Spec. SS-C-160A, Type IIIB, (ASTM C 449): Mineral fiber hydraulic-setting thermal insulating and finishing cement.
6. Other: Insulation manufacturer's published recommendations.

C. Mechanical Fasteners:

1. Pins, Anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
2. Staples: Outward clinching monel or stainless steel.
3. Wire: 18 gage soft annealed galvanized, or 14 gage copper clad steel or nickel copper alloy.
4. Bands: 3/4-inch nominal width, brass, aluminum or stainless steel.

D. Reinforcement and Finishes:

1. Glass Fabric, Open Weave: ASTM D 1668, Type III (resin treated) and Type 1 (asphalt treated).
2. Glass Fiber Fitting Tape: Mil. Spec. MIL-C-20070, Type II, Class 1.
3. Tape for Flexible Unicellular Insulation: Scotch No. 472, Nashua PE-12, or approved equal recommended by the insulation manufacturer.
4. PVC Fitting Cover: Fed. Spec. L-P-535D, Composition A, Type II, Grade GU, with Form B mineral fiber insert, for media temperature 45 Deg. F. to 250 Deg. F. Below 45 Deg. F. and above 250 Deg. F., provide double layer insert. Provide color matching, vapor barrier, pressure sensitive tape.

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- E. Firestopping Material: Refer to Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

PART 3 – EXECUTION

3.1 GENERAL INSULATION REQUIREMENTS

- A. Required pressure tests of joints and connections shall be completed before application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale, and rust removed.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use necessary means to protect his work and materials.
- C. Except for specific exceptions, insulate entire specified equipment and piping systems. Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.
- D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings. Vapor barriers shall be continuous and uninterrupted throughout systems with operating temperature 60 Deg. F. and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports, and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of six inches.
- E. Insulation on hot piping and equipment shall be terminated square or beveled with insulating cement, covered with jacket, at items not to be insulated, access openings and nameplates.
- F. On cold systems, vapor barrier performance is extremely important. Particular care must be given to vapor sealing the fitting cover or finish to the insulation vapor barrier. All penetrations of the jacket and exposed ends of insulation must be sealed with vapor barrier mastic. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion.
- G. Plumbing Work Not To Be Insulated:

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1. Chromium plated brass piping.
 2. Domestic Hot Water: Unions, flexible connectors, control valves, expansion tank, pump.
- H. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastics and coatings at the manufacturer's recommended minimum coverage.
- I. New insulation (as specified herein) shall be provided and installed for existing piping at all locations where insulation has been removed during asbestos abatement and/or demolition of adjoining equipment. Contractor shall obtain and examine the asbestos abatement documents to determine the extent of the work.
- J. Where hot, cold and/or tempered water piping are bundled together, each pipe shall be insulated individually to prevent transfer of heat to other piping systems.

3.2 INSULATION INSTALLATION

A. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor barrier penetrations with vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports.
2. Fittings, Flange and Valve Insulation:
 - a. Fiberglass Pipe insulation shall be installed with joints butted firmly together. Valves and devices requiring access shall be insulated with mitered sections of insulation equal in thermal resistance and thickness to the adjoining insulation. Fittings shall be covered with Schuller "Zeston" type, pre-molded PVC fitting covers. Jackets on pipe insulation shall be stapled using outward clinching type staples spaced 3" apart at least 1/4" from the lap edge on systems operating at 80 Deg. F. and above; below 80 Deg. F. the laps are to be vapor sealed using self-sealing lap, lap seal gun, or adhesive. All insulation joints, laps, voids, punctures, and end tapers shall be sealed with 1/32" thickness of Foster Vapor-Safe or Vapor-Fas adhesive regardless of service.
 - b. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least two inches.

B. Elastomeric Insulation:

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1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions.
2. Pipe and Tubing Insulation:
 - a. Use proper size material. Do not stretch or strain insulation.
 - b. To avoid undue compression of insulation, provide inserts at supports as recommended by the insulation manufacturer. Insulation shields are provided under Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.
 - c. Elastomeric insulation shall be slipped on the pipe prior to connection wherever possible. Pipe leak tests shall be performed prior to the insulation of fittings. Where the slip-on technique is not possible longitudinal slit insulation shall be snapped on the pipe. All seams, voids, and butt joints shall be sealed with a vapor barrier adhesive or taped with 1-1/2 inch wide 3M #471 tape.
 - d. Fittings and valves shall be insulated with mitered sections of insulation. All joints shall be secured and sealed with vapor barrier adhesive. Approved factory-made fittings such as F & D Mfgr. and Supply Co. may be used.

END OF SECTION 220700

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SECTION 220900 - INSTRUMENTATION AND CONTROL FOR PLUMBING

PART 1 - GENERAL

1.1 CONDITIONS

- A. The applicable provisions of Section 220000, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 22 00 00 carefully as items of work applicable to this section are included in Section 22 00 00.

1.2 DESCRIPTION OF WORK

- A. Furnish and install the system of automatic temperature controls (ATC) as shown on the contract drawings and hereinafter specified, for a complete and functioning system.
- B. Control sequences are specified in this section.
- C. Refer to Division 26 sections for the following work; not work of this section.
 - 1. Power supply wiring for power source to power connection on controls and/or unit control panels.
 - 2. Starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- D. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
 - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.
 - 2. Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electric/electronic control equipment, of types and sizes required.
- B. Installer's Qualifications: Firms specializing and experienced in electric/electronic control system installations for not less than three (3) years.

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C. Codes and Standards:

1. Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.
2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.

1.4 RELATED WORK

- A. Section 220000, PLUMBING GENERAL REQUIREMENTS.
- B. Section 221123, PLUMBING PUMPS

1.5 SUBMITTALS

- A. In accordance with Section 220000, PLUMBING GENERAL REQUIREMENTS, furnish the following:
 1. Product Data: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials and including installation instructions and start-up instructions.
 2. Shop Drawings: Submit shop drawings for each control system, containing the following information:
 - a. Schematic flow diagram of system showing pumps, valves, and control devices.
 - b. Label each control device with setting or adjustable range of control.
 - c. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.
 - d. Provide details of faces of control panels, including controls, instruments, and labeling.
 - e. Include verbal description of sequence of operation.
 3. Maintenance Data: Submit maintenance instructions and spare parts list. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Section 220000, PLUMBING GENERAL REQUIREMENTS.

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1.6 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements.

2.2 GENERAL

- A. Provide automatic temperature control products in sizes and capacities indicated, consisting of valves, sensors and other components as required for a complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide control systems with following functional and construction features as indicated.

2.3 CONTROL WIRING

- A. Provide control and interlock wiring, associated control system wiring, and pilot circuit wiring to accomplish any control sequence or function shown on the drawings, or plumbing systems and equipment specification.
- B. Associated control system wiring is defined as that wiring that powers or controls any control device provided for control of plumbing systems and equipment.
- C. Pilot circuit wiring is defined as that wiring that powers or controls any starter and other controller furnished as a component of plumbing systems and equipment and that is interposed in the power wiring; e.g., wiring from a safety device to the starter, and wiring from one starter to another for control interlocks.
- D. Power wiring is not included in this section.

2.4 THERMOSTAT

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- A. Immersion aquastats in recirculating lines shall be Honeywell Type L4006A range 40-180 Deg. F., 5 degree differential. Complete with separable insertion well for pipe mounting, contacts shall be rated for 8 amps at 120 volts.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION OF AUTOMATIC TEMPERATURE CONTROL SYSTEMS

- A. General: Install systems and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.
- B. Electrical Work: All electrical work performed in the installation of the ATC system and the Energy Management System as described in this specification shall be per the National Electrical Code (NEC) and per applicable state and local codes. Conductors shall be protected by EMT conduit whenever those conductors are exposed, such as in mechanical rooms or risers, or where buried. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a minimum of 40 percent full. In no cases shall conduit smaller than 1/2-inch size be allowed. Conductors rated for use in return air plenums shall be used.

3.3 SEQUENCE OF OPERATION

-- OR --

- A. Domestic Hot Water Control:
 - 1. Recirculation Control: Immersion aquastat in the recirculating water line, as indicated on the drawings, shall cycle its respective domestic hot water recirculating pump (HWCP) to maintain the recirculating water at a predetermined temperatur

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3.4 ADJUSTING AND CLEANING

- A. Start-Up: Start-up, test, and adjust automatic temperature control systems. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- C. Calibration and Adjustments: After completion of the calibration, Contractor shall start up the system and perform all necessary testing and run diagnostic tests to ensure proper operation. An acceptance test in the presence of the Owner's representative or engineer shall be performed prior to substantial completion of project.

3.5 CLOSEOUT PROCEDURES

- A. Owner's Instructions: The ATC Contractor shall provide three copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the temperature control system supplied. This Contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than 2 hours, during normal working hours. Schedule instruction with Owner, provide at least 7-day notice to Contractor and Engineer of training date.
- B. Warranty and Service: All ATC devices shall be warranted to be free from defects in workmanship and material for a period of one year from the date of substantial completion of the project. Any equipment found to be defective during this period shall be repaired or replaced without expense to the Owner. Factory-authorized warranty service shall be available.

END OF SECTION 220900

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SECTION 221100 - FACILITY WATER DISTRIBUTION

PART 1 – GENERAL

1.1 CONDITIONS

- A. The applicable provisions of Section 220000, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 2200 0 carefully as items of work applicable to this section are included in Section 220000.

1.2 DESCRIPTION OF WORK

- A. The work includes providing a complete plumbing system including, but not necessarily restricted to, the following:
 - 1. Domestic water system to a point five feet away from exterior building walls.
 - 2. Installation and connections to miscellaneous equipment furnished by Owner.
 - 3. Connections to fixtures and equipment provided under other sections of these specification.
 - 4. Miscellaneous work as described herein, as shown on drawings, and as required for a complete system.

1.3 RELATED WORK

- A. Section 220000, PLUMBING GENERAL REQUIREMENTS.
- B. Pipe Insulation: Section 220700, INSULATION
- C. Water Heaters: Section 223300, DOMESTIC WATER HEATERS
- D. Plumbing Fixtures: Section 224000, PLUMBING FIXTURES
- E. Pumps: Section 221123, PLUMBING PUMPS

1.4 SUBMITTALS

- A. Manufacturer's shop drawings shall indicate that piping and equipment meet specified codes. (All piping, pump systems, equipment, and fittings that are connected to potable water systems, shall meet the 1996 Safe Water Drinking Act and the 2011 Reduction of

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Lead in Drinking Water Act, and where applicable, meeting NSF Standard 61, and be so labeled and be so certified.) **(All piping, pump systems, equipment, and fittings that are connected to potable water systems, shall meet the EPA Clean Drinking Water Act, and where applicable, meeting NSF Standard 61, and be so labeled and be so certified.)** In accordance with Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, furnish the following:

1. Manufacturer's Literature and Data:
 - a. Piping
 - b. Valves
 - c. Backflow Preventers
 - d. Strainers
 - e. Shock Absorbers
 - f. Circuit Setters
 - g. Thermometers
 - h. Pressure Gages
 - i. Access Panels
 - j. Hose Bibbs
 - k. Hydrants
 - p. Pipe Supports (except hangers)

PART 2 – PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL CEILING PLATES

- A. Provide in accordance with specifications in Section 220000, PLUMBING GENERAL REQUIREMENTS.

2.2 WATER SERVICE CONNECTIONS TO BUILDING

- A. All interior and exterior copper tubing shall be Certified Tube (NOT Standard Tube or Streamline Tube) meeting all chemical, mechanical AND dimensional requirements of the applicable ASTM standards.
- B. From inside face of exterior wall to a distance of approximately five feet outside of building and underground inside building, material shall be as follows:
 1. 3 Inch Size and Larger: Cement-lined ductile-iron pipe, AWWA C151. Fittings, AWWA C110, Class 250. Pipe and fittings shall have cement-mortar lining, AWWA C104, standard thickness. Joints shall be caulked. Certified Copper

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tubing (not Standard Tube), ASTM B88 Type K, seamless, fittings as specified for Interior Domestic Water Piping using brazed joints with brazing alloys (AWS A5.8). Piping material shall be continuous from municipal connection to interior of building.

2. Less Than 3 Inch Size: ASTM B 88, type K, seamless, annealed. Copper tubing shall meet ALL ASTM requirements including but not limited to chemical, mechanical and dimensional requirements. Fittings as specified for Interior Domestic Water Piping using brazed joints with brazing alloys (AWS A5.8).

2.3 INTERIOR DOMESTIC WATER PIPING (DISTRIBUTION)

A. Copper Tube and Fittings:

1. Tube: ASTM B 88:
 - a. Above ground: Type L, hard drawn.
 - b. Below ground: Type K, hard drawn.
2. Fittings: Wrought copper, ASME B16.22 or cast copper alloy ASME B16.18. Victaulic or accepted equal full flow copper fittings with grooved ends. Grooved copper fittings shall be copper per ASTM B75 alloy C12200; bronze sand cast per ASTM B-584 copper alloy CDA 844 (81-3-7-9) per ANSI B16.18.
3. Joints:
 - a. Above ground: Soldered in accordance with ASTM B828, ASTM B32 lead free solder, ASTM B813 lead free flux. Lead free shall mean less than 0.2 percent lead. Grooved end copper piping systems as manufactured by Victaulic Company of America or accepted equal may be installed 2" – 8". For grooved end systems, couplings shall be copper tubing sized manufactured to ASTM A536 ductile iron Grade 65-45-12 painted copper color alkyd enamel. Gaskets for grooved system shall be of flush seal pressure responsive design having properties as designated in ASTM D2000. Installation-Ready, for direct slab installation without field disassembly. Victaulic Style 607H or equal.
 - b. Gaskets shall be UL classified in accordance with ANSI/NSF-61 for Potable water service.
 - c. Below ground: Brazed with AWS A5.8 filler metal (lead free).

B. Brass, Copper, Chromium-plated nipples - ASTM B687.

- C. Press Fittings: Copper press fittings by Viega, Ridgid Tool Company or accepted equal, requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM.

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- D. Push-to-Connect Fittings: Copper push-to-connect fittings by Sharkbite, Victaulic Company, "Permalynx", Mueller "ProLine", meeting requirements of ASME B16.18 or ASME B16.22, with stainless steel internal components and EPDM seals.
- E. All valves on domestic water piping shall be installed BELOW ductwork and other piping for ease of access.

2.4 EXPOSED WATER PIPING

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, including those furnished by the Owner or specified in other sections.
 - 1. Pipe: Red brass, standard weight, chrome plated.
 - 2. Fittings: Screwed brass or bronze, Class A, 125 pound, drainage pattern for waste.
 - 3. Nipples: Brass, standard weight.
 - 4. Unions: Brass or bronze. Unions 2-1/2 inches and larger shall be flange type with approved gaskets.

2.5 VALVES

- A. General: All valves and specialties shall be suitable for 125 psi working pressure except as otherwise indicated. Each item shall have threaded, flanged, or sweat connections as applicable to match joints specified for its respective service.
- B. Valves:
 - 1. Hot and Cold Domestic Water Service Acceptable manufacturers subject to compliance with requirements are Nibco, Jenkins, Hammond, Milwaukee, Lunkenheimer, Watts and Victaulic.
 - a. Gate valves (Rising Stem): Valves 2 1/2 inch and smaller shall be Class 125 rising stem, union bonnet, solid wedge and manufactured in accordance with MSS-SP 80. Body, bonnet and wedge shall be of bronze ASTM B-62. Stems shall be of dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy B-99, non-asbestos packing and malleable or ductile iron handwheel. Where higher operating pressures approach 150 psi, Class 150 union bonnet valves of like construction shall be used. Valve ends shall be threaded or solder-type. [Class 125 NIBCO T124 (threaded); Class 150 NIBCO T134 (threaded), S134 (solder)].

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- b. Ball valves: Valves 2 1/2 inch and smaller shall be rated 150 psi SWP and 600 psi non-shock WOG and shall have 2 piece cast bronze bodies, TFE seats, full port, separate packnut with adjustable stem packing, anti-blowout stems and chrome-plated brass/bronze ball. Valve ends shall have full depth ANSI threads or extended solder connections and be manufactured to comply with MSS-SP110. [NIBCO T585-70-LF (threaded); S585-70-LF (solder)] [Victaulic Company Series 722 (threaded); PL300 (push-to-connect, 200 psi)].

Note: Where piping is insulated, ball valves shall be equipped with 2" extended handles of non-thermal conductive material. Also, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Memory stops, which are fully adjustable after insulation is applied, shall be included. [NIBCO T585/70NS (threaded); S585-0NS (solder)]

- (1) Valves 2 inch and smaller shall be Y-pattern swing-type manufactured in accordance with MSS-SP80, Class 125, bronze ASTM B-62 body with TFE seat disc. Where higher operating pressures approach 150 psi, Class 150 valves of like construction shall be used. Valve ends shall be threaded or solder-type. [Class 125 NIBCO T413-Y (threaded); S413-Y (solder); Class 150 NIBCO T433-Y (threaded); S433-Y (solder)]
- C. Hose bibbs: (Toilets) Chicago 293-CP or equal, loose key, chrome plated, 1/2 inch size, with wall flange.
- D. Hose bibbs and hose-end drain valves: (Equipment rooms and similar spaces). Watts LFSC-5 (1/2 inch) or LFSC-6 (3/4 inch), Matco-Norca 646 RLF or equal rough brass, lead-free.
- E. Wall hydrants: Watts HY-420, Josam Series 71350 lead free, Prier C-534, Zurn Z1310, Smith 5619, or equal, cast bronze, non-freeze type with (polished bronze) (satin Nikaloy exterior) face, integral vacuum breaker, renewable seat, loose key, for servicing from outside. Mount 18" above finished grade.
- F. Shock Absorbers: Josam "Absorbotron" 75000 Series, Smith 5000 Series "Hydrotrols", Zurn Z1700 "Shoktrols", Wade "Shokstop" or equal, bellows type, lead-free, stainless steel. (SA-A Max. 11 SFU; SA-B Max. 32 SFU; SA-C Max. 60 SFU; SA-D Max. 113 SFU; SA-E Max. 154 SFU). Provide on both hot and cold water branches. Job fabricated air chambers will not be permitted. O-ring type shock absorbers will not be accepted. (ASME/ANSI A112.26.1 OR ASSE 1010)
- G. Balancing valves shall be circuit setters as manufactured by (Bell and Gossett) (Watts) (Tour Andersson) (Victaulic) or equal, and shall be a balancing valve of lead free all

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bronze construction, suitable for use in potable water systems. Valve shall have pressure taps with built-in check valves to determine pressure drop across valve. The pressure drop and the setting of the valve shall determine the actual system flow rate requirement. Valve shall be furnished with adjustable memory stop or locking device so the valve can be closed without disturbing the setting and be returned to the balanced position without further adjustment, and preformed polyurethane insulation suitable for use on domestic hot water and cold water systems. Unit to be suitable for minimum 175 psi working pressure at minimum 230 Deg. F. operating temperature. Tour Andersson Circuit Balancing valves containing digital readout handwheel for balancing hidden memory feature with locking tamper-proof setting and EPDM o-ring seals may be used. 1/2" – 2" shall be 300 PSI. A metal brass copper alloy body. 2-1/2" and larger shall be 300 psi grooved end.

2.6 BACKFLOW PREVENTERS

- A. Provide a backflow prevention device at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. Device shall be same size as line in which installed. Device shall be certified by recognized testing laboratory listed. Provide air gaps with drains pipe the same size as vent discharge on all backflow preventers with atmospheric vent. Extend drain to nearest floor drain. Listed below is a list of connection to the potable water system which shall be protected against backflow or back siphonage:
1. Reduced Pressure Backflow Preventer (ASSE 1013; AWWA C511; CSA CAN/CSA-B64.4): Watts Series 909, Series 009 or equal, complete with strainer, test cocks, and valves. Install top of backflow preventer 4'-0" above floor.
 - a. Water service entrances
 2. Hose Vacuum Breaker Type (ASSE 1011; CSA CAN/CSA-B64.2):
 - a. Watts No. NF8C or equal, with non-removable and manual drain feature for freezing conditions. (New and) Existing wall hydrant (if not provided as an integral part of the Hydrant)
 - b. Watts No. LF8A, LF8AC (chrome finished) or equal, lead free, with non-removable feature. Hose bibbs and sinks with threaded outlets
 - c. Watts 008PC-QT (spill resistant) or equal
 - (1) Commercial laundry equipment
 3. Intermediate Atmospheric Vent Continuous Pressure Type (ASSE 1024; CSA CAN/CSA-B64.6): Watts No. LF7R lead-free or equal.

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2.7 PRESSURE GAGES FOR WATER

- A. Gages for water pressure shall be Weksler Type HA14-4, 4-1/2 inch diameter dial, 1/4" NPT connection size, all metal aluminum case, bottom connected. Dials shall be black on white background throughout, 1 psi graduation, 20 psi figure graduation, brass bourdon tube and socket. Range shall be 0 to 160 psig. Provide tee handle cock and brass pressure snubber for water service.

2.8 THERMOMETERS

- A. Thermometers for water temperature shall be Weksler Type AS5H-9-AL or equal, adjustable angle form, blue spirit mercury-free column approximately 9 inches long, 30 to 240 Deg. F. range, 2 degree increments and complete with brass well.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Suspended horizontal piping shall be supported by adjustable wrought steel clevis hangers. Where supports bear on copper pipe, they shall be copper plated. Chain, strap, wire or other make-shift devices will not be permitted as hangers or supports. Hangers on all insulated pipes shall go around the insulation, with galvanized sheet steel saddle of sufficient size and thickness to prevent crushing of the insulation. Risers shall be securely supported and braced in an approved manner. Hangers for metal piping shall be spaced not over 6 feet apart for pipe 1/2 inch or smaller, 8 feet apart for 3/4 inch pipes and not over 10 feet apart for pipes 1 inch or larger. Hangers shall be located at all changes in direction. Maximum pipe support spacing shall be in accordance with Table 1 – MAXIMUM PIPING SUPPORT SPACING, except where grooved couplings are used, no pipe length shall be left unsupported between any two grooved couplings:

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Table 1 - Maximum Piping Support Spacing

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
Copper or Copper-Alloy Pipe	12	10
Copper or Copper-Alloy Tubing, 1¼-inch Diameter and Smaller	6	10
Copper or Copper-Alloy Tubing, 1½-inch Diameter & Larger	10	10
PVC Pipe	4	10 ^c
<p>For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm</p> <p>a. See Section 301.18.</p> <p>b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.</p> <p>c. Mid-story guide.</p>		

2. Install branch piping for water from the respective piping systems and connect to all fixtures, valves, outlets, and equipment, including those furnished by the Owner or specified in other sections of these specifications. Approximate locations for roughing-in are shown on the contract drawings. No piping or roughing-in shall be started until data showing exact locations for equipment and connections required are provided by the Architect. This data shall then be used for roughing-in equipment. Individual stops and other connection components not furnished with the equipment, but required for a complete installation, shall be provided under this section of these specifications. All exposed trim and fixture supply pipe, except in laundry, shall be chrome-plated.
3. Install trim and fittings provided with casework, cabinets, and laboratories, but not installed at point of fabrication.
4. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
5. All pipe runs shall be laid out and scheduled to avoid interferences with other work.
6. Press connections: Copper press fittings shall be made in accordance with the manufacturers installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

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7. Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible. Isolation gate valves shall be installed on each side of each major piece of equipment and at other points indicated or required for draining, isolation, or sectionalizing purposes. Discharge of relief valves and backflow preventers shall be piped full size of valve connection to 6 inches above nearest floor drain or to exterior concrete pad as marked on drawings. Pipe shall be supported so that weight of pipe is not on valve body. Trap primers shall be piped full size to the floor drain indicated.
8. Exterior cold water main shall have a minimum of 36-inch cover unless indicated otherwise on drawings.
9. Unions or flanged joints shall be provided on each side of each valve 2-1/2 inch or larger and in each line immediately preceding the connection of each major piece of equipment. Unions shall be 125 psi bronze seat type. Flanges shall be ANSI standard 125 psi service with 1/16 inch thick composition or red rubber gaskets. Where grooved end piping and butterfly valves are used, Victaulic Style 608 valves with 607H couplings will be considered unions.
10. Joints between pipes of dissimilar metals shall have dielectric fittings such as unions, flanges or Clearflow dielectric nipples to isolate metals. Isolation shall be accomplished by non-metallic sleeves or couplings of materials suitable to withstand temperatures and pressures encountered.
11. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. A distributor's representative is not considered qualified to conduct the training or jobsite visits.
12. Anchors for pipe shall be provided at all flush valves and fixtures or where required to localize pipe movement. Anchors shall consist of brass collars bolted to the pipe and rigidly connected to the building structure in an approved manner and so as not to damage the building structure.
13. Provide manufacturer's certification of all Pro-Press piping installations for full manufacturer's warranty.

B. Piping shall conform to the following:

1. Domestic Water:
 - a. Grade all lines to facilitate drainage. Provide hosed-end drain valves at bottom of risers. All unnecessary traps in circulating lines shall be avoided.

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- b. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.
- c. Provide drain lines from reduced pressure backflow preventers to nearest floor drain or to exterior concrete pad.

3.2 PROTECTION OF ELECTRICAL EQUIPMENT

- A. Refer to Specification Section 220000, Paragraph 3.01.C.1 for requirements for piping above electrical equipment.

3.3 TESTS

- A. General: Contractor shall provide all instruments, materials, and labor required. Tests shall be made in the presence of the Owner or Authority having jurisdiction or as otherwise directed by the Architect, who shall be given five (5) days notice by this Contractor of his readiness to perform such tests. Any leaks that develop during the tests shall be repaired by remaking the joint or replacing pipe and fittings. Temporary caulking will not be permitted. No piping shall be insulated or concealed until it has been tested, with results acceptable to the Architect. Air testing will be acceptable where permitted by the Virginia Uniform Statewide Building Code. Do NOT perform air testing on systems where plastic piping, including CPVC and PEX piping, are installed. Test systems either in its entirety or in sections.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 125 psig or at 50 percent higher than actual operating pressure which ever is greater for one hour during inspection and prove tight without any loss of pressure.
- C. Optional tests for connections to existing systems: After installation of piping and connecting to existing systems, and where herein before specified tests are impractical, test all new piping under actual operating conditions and prove tight to the satisfaction of the Architect.
- D. Reduced pressure principle backflow preventers, double check-valve, assemblies, and pressure vacuum breaker assemblies shall be tested to determine whether they are operable. The testing procedure shall be in accordance with one of the following:
 - 1. Reduced Pressure Principle: ASSE 5010-1013-1-91 with August 1992 Revisions.
 - 2. Double Check-Valve: ASSE 5010-1015-1-91 with August 1992 Revisions; ASSE 5010-1015-2-91 with August 1992 Revisions; ASSE 5010-1015-3-91 with August 1992 Revisions; ASSE 5010-1015-4-91 with August 1992 Revisions.

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3. Pressure Vacuum Breaker: ASSE 5010-1020-1-91.

3.4 DISINFECTION COPPER PIPING SYSTEMS

- A. After tests have been successfully completed, thoroughly flush and disinfect the interior domestic water distribution system in accordance with the local Health Department. In the absence of a prescribed procedure, systems shall be disinfected in accordance with AWWA C651 or AWWA C652.
- B. Optimal Disinfection: After all tests have been satisfactorily completed, the entire water distribution system shall be thoroughly flushed and disinfected. Disinfect by tapping the main and introducing a solution of chlorine and water in such quantity as to provide a concentration of not less than 50 PPM with all water lines filled with water from the water main connection to all supply outlets. Care shall be taken not to flush the lines at this time. Air only shall be allowed to escape. This solution shall be allowed to stand in the lines for not less than twenty-four hours, after which the lines shall be flushed out until a residual reading of 0.5 PPM is obtained.

3.5 CLEANING

- A. Remove trash, plaster, dust, paint spots and all foreign matter from outside of all piping and equipment.
- B. The Contractor shall check each length of pipe before it is put in place to make certain there is not foreign material (stones, sand, etc.) in the systems. Provide temporary bypass around equipment if or as required. All plumbing pipes shall be thoroughly flushed with water to remove construction debris before final connections are made to equipment and fixtures.

3.6 REPORTS

- A. Reports of cleaning, disinfection and testing: Contractor shall verify *in writing before completion of the job* that all specified cleaning procedures, tests, and disinfection have been performed, with results as specified or as required by codes.

END OF SECTION 221100

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SECTION 221123 - PLUMBING PUMPS

PART 1 – GENERAL

1.1 CONDITIONS

- A. The applicable provisions of SECTION 220000 - PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section, and the Contractor is cautioned to read Section 220000 carefully as items of work applicable to this section are included in Section 220000.

1.2 DESCRIPTION OF WORK

- A. Domestic hot water circulating pumps

1.3 RELATED WORK

- A. SECTION 220000 - PLUMBING GENERAL REQUIREMENTS.
- B. SECTION 220900 – INSTRUMENTATION AND CONTROL FOR PLUMBING.

1.04 SUBMITTALS:

- A. In accordance with SECTION 220000 - PLUMBING GENERAL REQUIREMENTS, furnish the following:
 - 1. Manufacturer's Literature and Data:
 - a. Domestic hot water circulating pump

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Domestic hot water circulating pump shall be U.L. Listed Bell & Gossett Little Red (Model LR-20BF iron body) (Model LR-15B bronze body) Booster Pump or equal complete with U.L. Listed motor, glass filled Noryl enclosed impeller, carbon steel shaft, mechanical seals, bronze-sleeve oil lubricated bearings. Unit maximum working pressure shall be 125.0 psi at a maximum operating temperature of 225.0 Deg. F. The

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motor shall be non-overloading at any point on the pump curve. Motor shall be open, drip proof, sleeve-bearing, quiet-operating construction. The permanent split capacitor motor shall be equipped with thermal overload protection. Motor rating shall be (1/20 HP, 115 volts, 60 Hertz, single phase at 2900 RPM) (1/12 HP, 115 volts, 60 Hertz, single phase at 3150 RPM). (The pump shall have a capacity of 14 GPM at 15 feet head.

- B. Time clock shall be Paragon Model EC7000 Series, Tork EW120 Series or equal, 120 volt, with 24-hour and 7-day programming capability, 16 available setpoints, keyboard override, 4-day power outage carryover without battery and NEMA 1 enclosure.

PART 3 – EXECUTION

3.01 INSTALLATION

3.02 TESTS

- A. Make tests under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat tests.

END OF SECTION 221123

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SECTION 221300 - DRAINAGE SYSTEMS

PART 1 – GENERAL

1.1 CONDITIONS

- A. The applicable provisions of Section 220000, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 220000 carefully as items of work applicable to this section are included in Section 220000.

1.2 DESCRIPTION OF WORK

- A. The work includes providing a complete plumbing system including, but not necessarily restricted to, the following:
 - 1. Sanitary sewer system to a point five feet away from exterior building walls.
 - 2. Connections to fixtures and equipment provided under other sections of these specification.

1.3 RELATED WORK

- A. Section 220000, PLUMBING GENERAL REQUIREMENTS.
- B. Pipe Insulation: Section 220700, INSULATION.
- C. Plumbing Fixtures: Section 224000, PLUMBING FIXTURES.

1.4 SUBMITTALS

- A. Manufacturer's shop drawings shall indicate that piping and equipment meet specified codes. In accordance with Section 220000, PLUMBING GENERAL REQUIREMENTS, furnish the following:
 - 1. Manufacturer's Literature and Data:
 - a. Piping
 - b. Valves
 - c. Floor Drains
 - d. Cleanouts
 - e. Pipe supports

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- I. IGCC Submittals: Submit product documentation indicating VOC content in g/L for all insulation material, field-applied interior adhesives, sealants and mastics.

PART 2 – PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL CEILING PLATES

- A. Provide in accordance with specifications in Section 220000, PLUMBING GENERAL REQUIREMENTS.

2.2 SOIL, WASTE, VENT, (AND EQUIPMENT VENT) PIPING

- A. Cast Iron Soil Pipe and Fittings: Used for pipe buried in or in contact with earth and for extension of pipe to a distance of approximately five feet outside of building walls. May be used for piping above ground, where space within partitions involved can accommodate greatest diameter of cast iron soil pipe without any dimension deviation from the requirements of contract drawings. Pipe shall be bell and spigot, modified hub, or plain end (no-hub) as required by selected jointing method. Pipe and fittings shall be listed by NSF International, IAPMO, ICC or other third party organization that is accredited as an ANSI-Guide 65 organization as listed on www.ansi.org. Drains from urinals shall be cast iron or PVC piping.
 1. Soil, Waste, and Vent Piping Material (Pipe and Fittings): ASTM A74, ASTM A888 or CISPI 301, service weight.
 2. Joints: Provide any one of the following types to suit pipe furnished.
 - a. Lead and oakum and caulked by hand.
 - b. Mechanical: Compression-type (ASTM C564) molded neoprene gasket. Gaskets shall suit class of pipe being jointed. Dual-service gaskets will not be accepted.
 - c. Mechanical: Mechanical joint coupling (ASTM C564) (CSA CAN/CSA-B602) shall consist of a stainless steel coupling and neoprene gaskets. Do not install below grade.
 - d. Adapters: Where service weight pipe is connected to extra heavy pipe and extra heavy fittings of chair carriers, provide adapters or similar system to make tight, leakproof joints.
 4. Coating: Provide a heavy coat of asphalt or bitumastic paint on pipe buried in earth or installed in cinders or concrete construction.
 5. Cast Iron Soil Pipe Markings: All cast iron soil pipe shall be clearly marked with the manufacturer's name, country of origin, eight-digit date code, pipe diameter

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and length, relevant ASTM standard and registered trademark of the third party certifier.

6. Material Test Reports: Supplier of cast iron soil pipe shall be able to supply material test reports in accordance with the relevant ASTM standard and shall include testing and analysis on radioactivity, dimensional characteristics, tensile strength and chemical/metallurgical content. Suppliers shall also supply MSDS sheets on all coatings.

- B. ***Plastic Pipe: May be used for piping above ground and below ground, sanitary forced main above and below ground. Foam core piping is NOT acceptable. All plastic pipe, fittings and components shall be third party certified as conforming to NSF 14. (PVC shall not be used where waste temperatures exceed 140 Deg. F., such as Kitchens and Mechanical Rooms.) (PVC shall not be used in return air plenums.) Schedule 80 PVC nipples will be acceptable for urinal connection.

1. Pipe: PVC Schedule 40 DWV, ASTM D 2665.
2. Soil, Waste, & Vent Fittings: PVC ASTM D3311 fittings for solvent joints.
3. Joints: ASTM F656 purple primer, solvent ASTM D2564 (Not Purple in color) complying with SCAQMD Rule #1168, joints made in accordance with ASTM D2855.

2.3 EXPOSED WASTE PIPING

- A. Finished Room: Use full size chrome plated brass piping for exposed waste piping connecting fixtures, including those furnished by the Owner or specified in other sections.
1. Pipe: Red brass, standard weight, chrome plated.
 2. Fittings: Screwed brass or bronze, drainage pattern for waste.
 3. Nipples: Brass, standard weight.
- B. Unfinished and Mechanical Rooms: Chrome-plated brass piping is not required. Paint as specified in Section 220000, PLUMBING GENERAL REQUIREMENTS.

2.4 CLEANOUTS

- A. Same size as pipe served up to 4 inches. Five and six inch mains shall have four-inch cleanouts, eight-inch mains six-inch cleanouts, ten inches and larger shall be eight inch cleanouts. Cleanouts shall be easily accessible. Provide a minimum of 18-inch clearance for 6 inch and smaller pipes, 36 inches for 8 inch and larger pipes, for rodding. Cleanouts shall be provided at the base of each soil stack, waste stack, vertical rain conductor at all points in sanitary drainage systems where direction change is more than 45 degrees, where required by code, and where indicated on the drawings. All cleanout plugs shall be bronze, set in graphite grease. All cleanout covers shall be

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secured with vandal resistant screws unless noted otherwise. (ASTM A74, ASME A112.3.1, ASME A112.36.2M) Covers shall be set flush with finished floor or wall unless otherwise indicated. Provide carpet markers in all carpeted areas.

1. Cleanouts at base of vertical stacks: Josam 58600-COT with stainless steel wall cover and tapped for center screw threaded bronze plug. Josam 58540-19 with 58600 wall cover for 8 inch size. Cleanout plug located approximately 30 inches above floor. Cleanout plugs under lavatories and sinks located approximately 10 inches above floor.
2. In horizontal runs above grade: Cleanouts shall be iron body ferrule with bronze screw plug in fitting or tapped cast iron ferrule with bronze plug.
3. In Floors: Floor cleanouts shall have cast iron body, bronze plug, and ABS or cast iron frame with round or square adjustable heavy-duty scoriated vandal resistant nickel bronze top. Unit shall be vertically adjustable for a minimum of two inches. When waterproof membrane is used in floor, provide clamping collars on cleanouts. Cleanouts shall consist of a "Y" fitting and a 1/8 bend. In carpeted areas, provide carpet cleanout markers.
 - a. For light traffic floors: Josam Series 55000-VP cast iron floor cleanout with (secured)(vandal resistant) round or square cover plate of satin bronze for finished concrete floors and of nickel-brass elsewhere.
 - b. For vinyl floors: MIFAB C1100-RFC, Jay R. Smith 2051-XP cast iron floor cleanout with (vandal-proof) (security) cover plate of satin bronze for finished concrete floors and of nickel-brass elsewhere, with membrane clamp.
4. Exterior Cleanout: Josam Series 55000-X-VP cast iron floor cleanout with cast iron vandal-resistant heavy-duty tractor cover. Extend cast iron soil pipe from sanitary sewer main two-way cleanout fitting and set cleanout in 12 inch x 12 inch x 6 inch concrete pad for 4 inch size and less, 16 inch x 16 inch x 6 inch pad for larger size. Top of cleanout and concrete pad to be flush with finished surface.

2.5 DRAINS

- A. Floor drains shall have outlets suitable for inside caulking. Provide suitable clamping device and extensions if required, where installed in connection with waterproofing membrane. Puncturing membrane other than for drain opening will not be permitted. All floor drains shall be furnished complete with 4-inch deep seal P-trap. All strainers shall be secured with vandal resistant screws unless noted otherwise. All floor drains and trench drains shall conform to ASME A112.6.3 or CSA B79.
 1. For single stall showers and drying stalls: Josam Series 30000-C-VP with cast iron body and collar, and vandal resistant six inch (diameter)(square) adjustable non-clog Nikaloy strainer with sediment bucket.
 2. For large mechanical room: Josam Series 32300-81-VP with cast iron body,

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3. For small mechanical room: Josam 30000-E-VP Series coated cast iron floor drain, two-piece body with double drainage flange, WEJLOC invertible non-puncturing flashing collar, weepholes, bottom outlet, adjustable satin Nikaloy vandal resistant round or square medium-duty tractor strainer, and perforated stainless steel basket.
- 4.
20. Trap sealer:
 - a. Sure Seal Model SS pre-assembled inline floor drain trap sealer. Sealer shall be constructed of high density polyethylene (HDPE) housing and keeper pin, heavy duty silicone diaphragm and soft EPDM sealing gaskets. Rated for floor ASSE-1072 AF-GW third party testing and listed by IAPMO. Provide in all floor drains.
 - b. Proset Model (TG22G-2”), (TG33G-3”), (TG34G-4”) Preassembled inline floor drain trap guard insert. The trap guard device shall be constructed of PVC insert, “O” Rings for 4 graduated sizes, elastomeric PVC flexible material diaphragm, sealed to pipe with adhesive caulk. Rated for ASME A112.6.3, NSF/ANSI 14 and CSA B79.
 - c. Mifab “Mi-Gard” Series inline floor drain trap seal device with UV resistant ABS plastic frame, silicon rubber sealing flapper and four flexible sealing ribs. Tested and certified to ASSE 1072 and listed with IAPMO and ICC.

- B. Laundry Trench Drain: J. R. Smith Model SQ-9-3615 lint trough, or equal, type 304 stainless steel, 144 inches long, 18 inches wide x 14 inches deep at outlet, with anchor tabs, removable 5/8 inch primary and 1/4 inch secondary stainless steel filter screens, dome bottom strainer covered with stainless steel mesh, 6 inch bottom outlet.
- C. Trench drains shall be Polydrain or approved equal as manufactured by ABT, Inc. Channels shall have interlocking joints and horizontal ribs to ensure a positive anchor in the encasement concrete. Properly fitting outlets, end caps and necessary catch basins shall be included. The grate shall be an ADA Polydrain No. 504 (510AF frame and grate assembly) or approved equal and be capable of being locked to the channel with removable lock downs. Provide a 900 Series small catch basin with steel trash bucket in each trench drain. Trench drain shall be installed in accordance with manufacturer's instructions and details. Polyclip installation device shall be used to hold the channels to line and grade, prevent floatation and ensure proper concrete encasement.

2.6 TRAPS

- A. Provide traps on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple, cleanout, and setscrew escutcheons. Concealed traps may be rough cast brass. Slip joints not permitted on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe and size shall be as required by connected service or fixture. Traps for equipment with acid-resistant drain system shall be of the same material specified for acid-resistant piping or Polypropylene. Provide 4 inch deep seal traps for all floor

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drains (and floor sinks) (and areaway drains) (and deck drains) (and trench drains) (hub drains). Provide traps with trap primer connections at all locations where trap primers are indicated.

2.7 WATERPROOFING

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth. Waterproofing shall consist of 6-pound sheet lead mopped-in between piles of waterproofing membrane. Flange out lead at opening for pipe and caulk into a cast iron pipe hub set just below line of membrane waterproofing to form watertight joint through floors.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Suspended horizontal piping shall be supported by adjustable wrought steel clevis hangers. Chain, strap, wire or other make-shift devices will not be permitted as hangers or supports. Hangers on insulated pipes shall go around the insulation, with galvanized sheet steel saddle of sufficient size and thickness to prevent crushing of the insulation. Risers and stacks shall be securely supported and braced in an approved manner. Hangers for plastic piping shall be 4 feet apart. Hangers shall be located at all changes in direction and at each joint for suspended soil, waste or storm branches and mains.
2. Install branch piping for waste from the respective piping systems and connect to all fixtures, outlets, casework, cabinets and equipment, including those furnished by the Owner or specified in other sections of these specifications. Approximate locations for roughing-in are shown on the contract drawings. No piping or roughing-in shall be started until data showing exact locations for equipment and connections required are provided by the Architect. This data shall then be used for roughing-in equipment. Individual traps and other connection components not furnished with the equipment, but required for a complete installation, shall be provided under this section of these specifications. All exposed trim and fixture pipe, except in laundry, shall be chrome-plated.
3. Install trim and fittings provided with casework, cabinets, and laboratories, but not installed at point of fabrication.
4. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, including plastic, shall be reamed to full size after cutting.
5. All pipe runs shall be laid out and scheduled to avoid interferences with other work.
6. Exterior storm sewer and exterior sanitary sewer piping shall have a minimum of 36-inch cover unless indicated otherwise on drawings. Exterior underground

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- PVC piping shall be buried in accordance with ASTM D2321 and the pipe manufacturer's recommendations.
7. Plastic pipe shall not be located in return air ceiling plenums, and shall not be located in above ceiling or attic spaces constructed of combustible material.
 8. Plastic pipe shall not penetrate a fire assembly or smokestop. Transitions from metal pipe to plastic pipe must be a minimum of 36 inches away from fire assembly or smokestop penetrations.
 9. Screwed joints for steel pipe shall be made with tapered threads, properly cut and all burrs removed. Pipe ends shall be reamed to full size of bore and all filings removed. Joints shall be made tight with an approved joint cement suitable for the service encountered and applied to the male threads only. A maximum of 3 threads shall show after joint is made up.
 10. Caulked joints for cast iron sewer pipe shall be made by packing each joint two thirds full with pure tarred rope oakum, and filling remaining 1/3 full of molten lead. Minimum lead depth shall be 2-1/2 inches.
 11. Compression gasket joints for cast iron sewer pipe shall be made with neoprene compression gaskets conforming to ASTM C-564 and suitable for use with hub and spigot pipe and fittings. Gaskets shall be installed in strict accordance with manufacturer's recommendations.
 12. No-hub joints for cast iron pipes shall be made with neoprene gaskets (ASTM C564) and stainless steel clamps conforming to ASTM C564 AND ASTM C1277. Joints shall be made in accordance with manufacturer's recommendations.
 13. Mechanical joints elastomeric sealing sleeve for cast iron pipe shall be in accordance with ASTM C564.
 14. Solvent cement for PVC piping shall be handled in accordance with ASTM F402.
 15. Drains from urinals shall be cast iron or PVC, with brass or Schedule 80 PVC nipple connecting to urinal. Copper or galvanized steel will not be acceptable.

B. Piping shall conform to the following:

1. Waste and Rain Conductor:

a. Slope rain conductor and soil, waste and vent piping as follows:

Pipe Size	Minimum Pitch Down
Soil, waste, and vent	
2-1/2 inch & smaller	1/4 inch to the foot
3 inch & larger	1/8 inch to the foot
Rain conductor	1/8 inch to the foot

- b. Changes in direction of piping shall be made with fittings. Changes in direction of drainage piping shall be made by the appropriate use of long-sweep 1/4 bends, 1/6, 1/8, or 1/16 bends, 45 degree wyes, 1/2 wyes, or a combination of these fittings, except that changes in direction of flow from the horizontal to the vertical may be made with short-sweep 1/4 bends.

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- c. Contractor is cautioned to locate and verify invert of existing sanitary and storm sewer and to coordinate inverts of new work to suit existing conditions.
- d. Sanitary sewer shall be provided complete with all plumbing fixtures, drains, etc., properly connected and vented in accordance with the applicable codes. All vents through the roof, including existing vents-through-roof where existing roofing is being replaced and roof slopes are revised, shall extend a minimum of twelve inches above the roof.

3.2 PROTECTION OF ELECTRICAL EQUIPMENT

- A. Refer to Specification Section 220000, Paragraph 3.01.C.1 for requirements for piping above electrical equipment.

3.3 TESTS

- A. General: Contractor shall provide all instruments, materials, and labor required. Tests shall be made in the presence of the Owner or Authority having jurisdiction or as otherwise directed by the Architect, who shall be given five (5) days notice by this Contractor of his readiness to perform such tests. Any leaks that develop during the tests shall be repaired by remaking the joint or replacing pipe and fittings. Temporary caulking will not be permitted. No piping shall be insulated or concealed until it has been tested, with results acceptable to the Architect. Except for plastic piping, air testing will be acceptable for other piping materials where permitted by the Virginia Uniform Statewide Building Code. Test systems either in its entirety or in sections.
- B. All repairs required to existing underground sanitary and storm drainage systems to be reused, where deficiencies are discovered during testing or construction, shall be addressed by change order, or shall be addressed separately by the owner.
- C. Soil, Waste, and Vent Systems: Conduct tests before trenches are backfilled or fixtures are connected. Conduct water test or air test, as directed in accordance with the Virginia Uniform Statewide Building Code and this specification.
 - 1. Water Test: If entire system is tested, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least 10-foot head of water. In testing successive sections, test at least upper 10 feet of next preceding section so that each joint or pipe except uppermost 10-foot head of water. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
 - 2. All exterior storm sewers 6 inch diameter and less shall be tested to a minimum of 10 feet of water pressure. Larger sizes shall be visually checked for quality of

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work, and shall also be checked by a lamp test between manholes and turning points where possible.

3. Final Test: When required by the Building Inspector, conduct as directed in accordance with Virginia Uniform Statewide Building Code and this specification. Either one of the following tests may be used:
 - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke. When smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be held for a test period of not less than 15 minutes. Chemical smoke prohibited.
 - b. Peppermint Test: Introduce two ounces of peppermint into each line or stack.
 - c. Air Test: Air test shall be made by forcing air into the system until obtaining a uniform gauge pressure of 5 psi or sufficient to balance a 10 inch column of mercury. This pressure shall be held for a test period of not less than 15 minutes. Testing procedures in excess of 5 psi can result in a dangerous situation and shall not be allowed. Plastic piping shall not be tested using air.
- D. Optional tests for connections to existing systems: After installation of piping and connecting to existing systems, and where herein before specified tests are impractical, test all new piping under actual operating conditions and prove tight to the satisfaction of the Architect.

3.4 CLEANING

- A. After tests have been successfully completed, thoroughly flush the interior drainage system.
- B. Remove trash, plaster, dust, paint spots and all foreign matter from inside and outside of all fixtures and equipment.
- C. The Contractor shall check each length of pipe before it is put in place to make certain there is not foreign material (stones, sand, etc.) in the systems. Provide temporary bypass around equipment if or as required. All plumbing pipes shall be thoroughly flushed with water to remove construction debris before final connections are made to equipment and fixtures.

3.5 REPORTS

- A. Reports of cleaning and testing: Contractor shall verify in writing before completion of the job that all specified cleaning procedures and tests have been performed, with results as specified or as required by codes.

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END OF SECTION 221300

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SECTION 223300 - DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 CONDITIONS

- A. The applicable provisions of Section 220000, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 220000 carefully as items of work applicable to the section are included in Section 220000.

1.2 DESCRIPTION OF WORK

- A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.
- B. In general, the work included under this section consists of, but is not limited to, the following:
 - 1. Domestic Water Heaters

1.3 RELATED WORK

- A. Section 220000, PLUMBING GENERAL REQUIREMENTS.
- B. Circulating Pump: Section 221123, DOMESTIC WATER PUMPS.

1.4 SUBMITTALS

- A. In accordance with Section 220000, PLUMBING GENERAL REQUIREMENTS, furnish the following:
 - 1. Manufacturer's Literature and Data:
 - a. Gas Hot Water Heaters

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PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements.

1. Ruud, Rheem, Bock, State, A.O. Smith

2.2 INSTANTANEOUS GAS WATER HEATER(S) (WHR- 1

A. WHR-1 water heater shall be A. O. Smith commercial on-demand tankless water heater indoor Model ATI-510U 200, 199,000 BTU/HR, MBH input with 10 GPM output @ _100 Deg. F.

B. The unit shall use direct electronic ignition with no pilot light, 83% efficiency rating, noise level 49 db, interior sealed combustion, (120V, 60 Hz, control 12 volts digital), shall have a maximum water supply pressure of 150 psi and minimum working pressure of 20 psi; shall have 0" (zero) required clearance back of heater to non-combustibles. Unit shall have wall installation brackets. The unit shall have 3/4 inch inlet and outlet.

C. Unit shall have a waterproof remote control temperature controller located in a limited access room. The temperature controller shall set temperature of water within the specific range. Controller shall include a thermostat, On-Off button, priority indicator and button, in-use indicator light, temperature display and error code display. Provide non-polarized two-core remote control cable (minimum 22 AWG).

D. Unit shall have a surge protector and electrical connections for installation of electrically-actuated drain down solenoid valves. If water heater is disabled due to an error code, then solenoid valves connected at surge protector and attached to PC board of unit will operate to drain unit of all water. In this event, two solenoid valves will operate. One 1" ASCO normally open 115V solenoid valve will close stopping the flow of water from heated space to heater. The other 1" ASCO normally closed 115V solenoid valve will open allowing the water heater and piping to drain to floor drain. An air vent will be located inside the building to assist draining of unit and will assist expelling air from system. Also, upon loss of electrical power, solenoid valves will operate as described above.

G. Provide Webstone Isolator ESP tankless water heater service valves EXP-PR (40443WPR on hot water side, 40443W on cold water side) complete inlet/outlet valve system for full port testing, flushing of the system, including pressure relief valve. Valves shall be 3/4", 600 WOG 150 WSP, quarter turn ball valve operation, brass construction with Teflon seats.

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- H. The heat exchanger shall have a five (5) year limited warranty, and a five (5) year warranty on all parts.
- J. Provide watts one flow model OFTWH anti-scale system, 95+% scale reduction, 3/4 inch connection size, 10 GPM peak flow rate, (Model OF110-1 for 1 GPM flow rate,) (Model OF120-2 for 2 GPM) (Model OF140-4 for 4 GPM), for vertical upright level installation only, with no liquid pipe compound- use Teflon tape only, must not be installed in direct sunlight, inlet ball valve for isolation, mounting bracket with filter wrench. (Not for closed loop systems) (Copper lines must be passivized for minimum 4 weeks before placing unit into service.) (Maximum Temp. 100 degrees F.,) (Max Pressure 90 psi) (Install within heated envelope of building, must not freeze.) The system shall be warranted for 5 years for materials and workmanship; the media performance for 2 years and cartridge for 1 year.

PART 3 - EXECUTION

3.1 WATER HEATERS

- A. All water heaters shall have an ANSI Z21.22 temperature and pressure relief valve with test lever. Valves shall have an AGA temperature rated capacity of not less than the installed heating capacity. Discharge pipe shall terminate no more than 6 inches above and not less than two times the discharge pipe diameter above the floor or drain pan flood level rim.
- B. Provide an ANSI Z21.22 Watts 3/4 inch Model LFN36-M1 or equal, bronze body and silicone disc vacuum relief valve on cold water supply to each heater. No valves or connections shall be made between vacuum relief valve and heater.
- C. Standby heat loss for water heaters shall conform to requirements of Section 4.3.1 of ANSI C72.1 and ASHRAE Standard 90-75.
- D. All water heaters shall have warranties equal to those specified for usage or application.
- E. Provide a Watts Model DET- potable water expansion tank on the cold water supply to the water heater. Unit shall have a thermally fused epoxy liner and butyl diaphragm. Precharge tank to domestic water system static pressure. (Support tank from building structure.)
- F. All aspects of installation of water heater shall be in strict accordance with manufacturer's instructions. Materials shall conform with all manufacturer's recommendations and shall include a stainless steel positive pressure U/L Listed vent

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system. Water heater shall have individually isolating shutoff valves for service and maintenance and a hot water hose connection for field testing.

- G. Contractor shall provide the services of a factory authorized representative to supervise all phases of equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted to the Engineer with operation and maintenance instructions.

3.2 PERFORMANCE TEST

- A. Prove system is balanced and 120 Deg. F is available at farthest outlet from heaters (110 Deg. F. at public lavatories).

3.3 PIPE DISCHARGE

- A. From relief valves to nearest floor drain.

END OF SECTION 223300

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SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 CONDITIONS

- A. The applicable provisions of Section 220000, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of the section and the Contractor is cautioned to read Section 220000 carefully as items of work applicable to this section are included in Section 220000.

1.2 DESCRIPTION OF WORK

- A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.
- B. In general, the work included under this section consists of, but is not limited to, the following:
 - 1. Plumbing Fixtures
 - 2. Plumbing Trim

1.3 RELATED WORK

- A. Section 220000, PLUMBING GENERAL REQUIREMENTS.

1.4 SUBMITTALS

- A. In accordance with Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, furnish the following:
 - 1. Manufacturer's Literature and Dimension Cuts:
 - a. Plumbing Fixtures & Carriers
 - b. Plumbing Faucets & Flush Valves
 - c. Plumbing Traps and Fittings
 - d. Plumbing Supplies & Stop Valves
 - e. Plumbing Equipment

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PART 2 - PRODUCTS

2.1 GENERAL

- A. Fixtures equal to those as hereinafter specified shall be furnished and installed complete with all supplies, waste and vent connections, all fittings, all necessary hangers and supports, bolt caps, faucets, valves and traps. All trim, (except in Janitor's Closets), shall be brass with polished chromium plated finish with chrome setscrew escutcheon at wall, except fixture supply pipes may be chromium plated copper with chrome setscrew escutcheons at wall. Traps shall be cast brass (17 gauge) with cleanout plug. All fixtures shall be white except as otherwise indicated. Handicapped lavatories and sinks shall have both water supplies and trap insulated and wrapped with Handy-Shield (by Plumberex), Handi Lav-Guard (by Truebro) or Prowrap (by McGuire). (Where below deck mixing valve or electronic faucet are specified, provide Zurn Model Z6900-V9 vandal guard enclosure or equal by Truebro.) Color shall be white and fasteners shall remain out of sight. All electric water coolers and drinking fountains shall have a dielectric fitting on the water supply and PVC trap on waste.

2.2 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements

Water Closets:	Zurn
Lavatories:	Zurn
Urinals:	Zurn
Sinks:	ProFlo
Mop Sinks, Laundry Tubs:	ProFlo
Electric Water Coolers:	Oasis, Elkay, Halsey Taylor
Flush Valves:	Zurn
Faucets:	Moen
Water Closet Seats:	Bemis
Shower Fitting:	Moen
Carriers:	Zurn

2.3 CODE COMPLIANCE

- A. Manufacturer's shop drawings shall indicate that fixtures, fittings and equipment meet specified codes. Fixtures, fittings or equipment materials for potable water system shall not contain lead. All plumbing fixtures, flush valves, flush valve operators, flush tank operators, faucets, and fittings designated for handicapped installation, shall meet ICC/ANSI A117.1-2003 and The Americans with Disabilities Act 2010 (ADA)

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requirements. Fittings and fixtures that are connected to potable water systems shall meet the 1996 Safe Water Drinking Act and the 2011 Reduction of Lead in Drinking Water Act, and where applicable shall meet NSF Standard 61 and shall be labeled and certified. Faucets that supply drinking water shall comply with NSF 9. *(Fittings and fixtures that are connected to potable water systems shall meet the EPA Clean Drinking Water Act and where applicable shall meet NSF Standard 61 and shall be labeled and certified.)**

B. Codes:

1. Vitreous china fixtures - ASME/ANSI A112.19.2M; ICC/ANSI A117.1-2003; ADA
2. Enameled cast iron fixtures - ASME/ANSI A112.19.1M; ICC/ANSI A117.1-2003; ADA
3. Flush valves & tanks - ASSE 1037 with ASSE 1001 vacuum breaker on flush valves; ICC/ANSI A117.1-2003; ADA
4. Lavatory & Closet carrier - ASME/ANSI A112.6.1
5. Porcelain enameled formed steel fixture - ASME A112.19.4M; ICC/ANSI A117.1-2003; ADA
6. Electric water coolers - ARI 1010; ICC/ANSI A117.1-2003; ADA
7. Stainless steel plumbing fixtures (sinks) - A112.19.3M; ICC/ANSI A117.1-2003; ADA
8. Faucets - ASSE 1025; ASME A112.18.1; ICC/ANSI A117.1-2003; ADA; NSF Standard 61 Section 9
9. Showers - ANSI Z124.2; ASME A112.19.9M, CSA B45.5; ADA
10. Hand-Held Shower - ASSE 1014; CSA CAN/CSA B125; ADA

2.4 STOPS

- A. Provide lock-shield, loose-key or screwdriver pattern polished chromium plated angle stops, with each sink faucet, lavatory faucet or tank type plumbing fixture. Faucets for service sinks or mop sinks shall have stops integral with faucet. Locate stops below fixture in accessible location. Flush valves and shower valves shall be furnished with integral stops.

2.5 ESCUTCHEONS

- A. Heavy duty solid type chrome plated brass with set screws.

2.6 FIXTURES

Designation	Standard Fixture Type
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- WC-1 Water closet: Zurn EcoVantage Z5615.258.00.00.00 HET Series,1.28 GPF Water-Saving, vitreous china elongated siphon jet bowl, wall hung, 1-1/2 inch top spud, Bemis #1955SSCT white extra heavy duty solid plastic open front seat without cover, self-sustaining check hinge. Zurn
Z6200-HETMetroflush piston-operated flush valve flush valve mounted 11-1/2 inches above bowl , vacuum breaker and vandal-resistant control stop cap assembly. Provide coordinated closet carrier similar to Zurn 1201-XB Series adjustable horizontal series and and Zurn Z1202 adjustable vertical series carrier as applicable.
- WC-2 Water closet: Zurn EcoVantage Z5615.258.00.00.00 HET Series,1.28 GPF Water-Saving, vitreous china elongated siphon jet bowl, wall hung, 1-1/2 inch top spud, Bemis #1955SSCT white extra heavy duty solid plastic open front seat without cover, self-sustaining check hinge. Zurn
Z6200-HETMetroflush piston-operated flush valve flush valve mounted 11-1/2 inches above bowl , vacuum breaker and vandal-resistant control stop cap assembly. Provide coordinated closet carrier similar to Zurn 1201-XB Series adjustable horizontal series and and Zurn Z1202 adjustable vertical series carrier as applicable.
- UR-1 Urinal: Zurn Omni-Flo Z5755-U.00 1.0 GPF Water-Saving, vitreous china, siphon jet, 3/4 inch top spud, 2" outlet and Zurn Z75755-U flush valve with vacuum breaker and vandal-resistant control cap assembly. (Provide flat iron plate 24 inch x 4 inch x 1/4 inch on back side of wall, or built into walls with urinal support bolts through plate to give added mounting strength.) (Provide coordinated urinal carrier similar to Josam Series 17560-UR single carrier with hanger plate, bearing plate, steel pipe uprights and block bases for each urinal). Mount top of front rim 24 inches above finished floor.
- L-1 Lavatory: Zurn model Z5340 vitreous china, concealed arm, wall hung, 4-inch centers, Moen Faucet 8215 with vandal-resistant lever handles, tailpiece with fixed perforated grate, vandal-resistant 0.5 GPM flow device, standard spout, Zurn model Z1231concealed arm carrier.
Provide Vandal Gard lavatory enclosure, or equal by Truebro.
- EWC-1 Electric water cooler (ARI 1010) : Oasis , Elkay LWAE8, lead free, air-cooled, hermetically-sealed non-CFC refrigeration system, wall mounted, Sandstone powder-coated paint on steel cabinet with one piece stainless steel top. Color as selected by Architect, minimum

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capacity 8.0 GPH of 50 Deg. F. water at 90 Deg. F. ambient, 80 Deg. F. inlet water. Provide coordinated EWC carrier similar to Josam Series 17560-WC with hanger plate, bearing plate, support rods, structural uprights, welded feet, adjustable supporting rods, and chrome plated trim.

SSK-1 Service Sink: Kohler Bannon K-6719, 24 inch x 20 inch, acid-resisting enameled cast iron, painted outside, stainless steel rim guard, K-8908 supply fitting with vacuum breaker, loose key stops in shanks, threaded spout with pail hook, top brace to wall, and K-6673, 3 inch trap standard.

MS-1 Mop Sink: Mop Sink: ProFlo model PFMB24S 24 inch x 24 inch x 10 inch molded stone mop service basin, MR-373, Zurn BV bumper guard, stainless steel drain body, combination S.S. dome strainer (NOT integral flat strainer) and lint basket, Fiat 830-AA, Florestone MR-371, Zurn SF, Chicago 897-RCF supply fitting with vacuum breaker, four arm handles, integral stops, wall brace, pailhook, threaded spout, Fiat 832-AA, Florestone MR-370, Zurn HH rubber hose and wall hook and Fiat 889-CC, Florestone MR-372, Zurn MH mop hanger, and MSG242.

SH-1 Shower: Leonard (ASSE 1016) ADA Model 4500-D-2L-H-06-515PG-30-VP pressure-actuated shower mixing valve with adjustable limit stop set for 110 Deg. F, check stops, institutional fixed shower head Model H-06 2.5 GPM polished chrome-plated brass with anchor plate, vandal-resistant screws and 2.5 GPM flow at 80 PSI control, wall mounting fasteners for valve and head shall be vandal-resistant single-blade handle, inline chrome-plated vacuum breaker EVB, chrome-plated diverter valve D-2L, with hand shower Model 515G with flexible 69-inch stainless steel braided hose, wall connection and flange, 30-inch slide bar for hand/shower mounting, 2.5 GPM flow at 80 PSI heads. Where shower valves are shown back to back, provide one valve with reverse coring, hot on right/cold on left installation. The shower riser pipes from the diverter valve to the shower arm outlets shall be attached to the building structure in an approved manner.

Designation Handicapped Fixture Type

WC-2 Water closet: Zurn EcoVantage Z5615.258.00.00.00 HET Series, 1.28 GPF Water-Saving, vitreous china elongated siphon jet bowl, wall hung, 1-1/2 inch top spud, Bemis #1955SSCT white extra heavy duty

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- solid plastic open front seat without cover, self-sustaining check hinge. Zurn
Z6200-HETMetroflush piston-operated flush valve flush valve mounted 11-1/2 inches above bowl , vacuum breaker and vandal-resistant control stop cap assembly. Provide coordinated closet carrier similar to Zurn 1201-XB Series adjustable horizontal series and and Zurn Z1202 adjustable vertical series carrier as applicable.
- UR-2 Urinal: Zurn Omni-Flo Z5755-U.00 1.0 GPF Water-Saving, vitreous china, siphon jet, 3/4 inch top spud, 2" outlet and Zurn Z75755-U flush valve with vacuum breaker and vandal-resistant control cap assembly. (Provide flat iron plate 24 inch x 4 inch x 1/4 inch on back side of wall, or built into walls with urinal support bolts through plate to give added mounting strength.) (Provide coordinated urinal carrier similar to Josam Series 17560-UR single carrier with hanger plate, bearing plate, steel pipe uprights and block bases for each urinal). Mount top of front rim 21 inches above finished floor.
- L-2 Lavatory: Similar to L-1 except mounting heights 34 inches finished floor to rim.
- SK-1 Sink: Elkay "Lustertone" ELUHAD191655, 21-1/2" X 18-1/2" x 5-3/8" deep ADA single bowl undermount type 304 18 gauge stainless steel sink, Chicago 1100-GN8AE35-369AB faucet, 8" centers, 8" gooseneck rigid/swing spout, 1.5 GPM at 60 psi discharge laminar flow device, 2-3/8" vandalproof lever handles, LKAD-35 strainer and LKADOS offset tailpiece.
- EWC-2 Electric water cooler: Similar to EWC-1 except mounting height 36 inches finished floor to spout outlet.
- EWC-3 Electric water cooler: (ARI 1010) Oasis Model P8ACSL air-cooled, hermetically-sealed, non-CFC refrigeration system, lead-free, front and side push bars, wall-mounted powder-coated paint on steel cabinet with one piece stainless steel top and flexible bubbler. Color as selected by Architect, minimum capacity 7.8 GPH of 50 Deg. F. water at 90 Deg. F. ambient, 80 Deg. F. inlet water. Provide coordinated EWC carrier similar to Josam Series 17560-WCBL with double hanger plates, double bearing plates, adjustable supporting rods, structural upright; welded feet and chrome plated trim. Mount unit on wall so low side spout outlet is 36 inches above finished floor.
- SH-2 Shower: Symmons (ASSE 1016) Model S-96-300-B30 Temptrol pressure balancing mixing valve shower control with integral volume control, adjustable stop screw to limit handle turn, integral service

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stops, in-line vacuum breaker, single blade lever handle wall/hand shower with flexible metal hose, wall connection and flange, 30-inch slide bar for hand shower mounting, and 2.5 GPM flow at 80.0 psi head. Where shower valves are shown back-to-back, provide one valve with reverse coring, hot on right, cold on left installation. The shower riser pipe from the shower valve to the shower arm outlet shall be attached to the building structure in an approved manner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Supports and Fastenings: Secure all fixtures, equipment and trimmings to partitions, walls, etc., with brass through bolts, toggle bolts, expansion bolts, or power set fasteners, as required. Exposed heads of bolts and nuts in finished rooms to be hexagonal, polished chromium plated brass with rounded tops.
- B. Through Bolts: For freestanding marble and metal stud partitions.
- C. Toggle Bolts: For hollow masonry units, finished or unfinished.
- D. Expansion Bolts: For brick or concrete or other solid masonry. To be 1/4-inch bolts, 20 threads per inch, and to extend at least three inches into masonry; to be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.
- E. Power Set Fasteners: May be used for concrete walls, shall be 1/4-inch threaded studs, 20 threads per inch, and shall extend at least 1-1/4 inches into wall.
- F. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- G. Where water closets are wall mounted or floor mounted, lavatories, urinals and water coolers are wall mounted, seal between water closet and wall or floor, and lavatory, urinal, or water cooler and wall, with a silicon caulking compound. Counter mounted lavatories or sinks shall be sealed between countertop and lavatory or sink. Where fixtures are white in color, the caulking compound shall be white. Where fixtures are stainless steel, use transparent caulking compound.

3.2 CLEANING

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- A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

END OF SECTION 224000

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SECTION 226000 - FACILITY NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 CONDITIONS

- A. The applicable provisions of Section 220000, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 220000 carefully as items of work applicable to this section are included in Section 220000.

1.2 DESCRIPTION OF WORK

- A. The work includes providing a complete gas piping system including, but not necessarily restricted to, the following:
 - 1. Natural gas piping system from gas meter.
 - 2. Installation and connections to miscellaneous equipment furnished by Owner.
 - 3. Connections to fixtures and equipment provided under other sections of these specifications.
 - 4. Miscellaneous work as described herein, as shown on drawings, and as required for a complete system.

1.3 RELATED WORK

- A. Section 220000, PLUMBING GENERAL REQUIREMENTS.

1.4 SUBMITTALS

- A. Manufacturer's shop drawings shall indicate that fixtures and equipment meet specified codes. In accordance with Section 220000, PLUMBING GENERAL REQUIREMENTS, furnish the following:
 - 1. Manufacturer's Literature and Data:
 - a. Piping
 - b. Valves
 - c. Gas Pressure Regulators
 - d. Pipe supports

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PART 2 – PRODUCTS

2.1 PIPE SUPPORTS, PIPE SLEEVES, AND WALL CEILING PLATES

- A. Provide in accordance with specifications in Section 220000, PLUMBING GENERAL REQUIREMENTS.
- B. Gas piping installed above roof surfaces shall be supported by an Erico Caddy Pyramid 50 Model RPS50H6EG polyethylene foam block (6"H x 4"W x 10-1/2"L) with 16 gauge steel top and integral strut channel for receiving standard strut clamps and accessories. Pipe pier shall be installed according to manufacturer's recommendations. Roof pipe supports shall be spaced according to specifications and shall be installed to allow for expansion and contraction.

2.2 INTERIOR GAS PIPING NATURAL GAS

- A. Pipe: Black steel, ASTM A 53 Grade B or A 106, Schedule 40.
- B. Nipples: Steel, ASTM A733, Schedule 40.
- C. Fittings, 2 Inches and Smaller: Malleable iron, ASME B16.3. (Threaded)
- D. Fittings, 2-1/2 Inches and Larger: Steel, Schedule 40 with ANSI B16.11 socket welded (4 inches and smaller), ANSI B16.9 butt-welded joints (over 4 inch size).
- E. Joints: Threaded ends (ASME B1.20.1). Pipe-joint compound or tape (Lochinvar, no Teflon tape) applied to male threads only; Welded. Do not use gas fitters cement, except on outlet caps.
- F. Gas piping installed in concealed locations shall not have unions, tubing fittings or running threads.
- G. Gas Regulator Vent Piping Above Grade: Same as natural gas piping above grade. PVC vent piping shall not be used indoors.

2.3 EXTERIOR ABOVE GROUND

- A. Pipe: Black steel, ASTM A 53 Grade B Schedule 40, or A 106, Schedule 40.
- B. Nipples: Black steel.

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- C. Fittings: Steel Schedule 40, ASME B16.9 (butt welded, 2-1/2 inch and larger), malleable iron, ASME B16.3 (threaded, 2 inches and smaller).
- D. Joints: Threaded ends (ASME B1.20.1). Pipe-joint compound or tape applied to male threads only; Welded. Do not use gas fitters cement, except on outlet caps.
- E. Factory applied Republic Steel Company plastic covering "X-TRU-COAT", for all exterior piping and fittings. Joints for exterior and underground piping and fittings shall be primed with "X-TRU-TAPE" primer and finished with "X-TRU-TAPE".
- F. Shop-applied pipe coating shall be one of the following types:
 - 1. Coal Tar Enamel Coating: Exterior of pipe and fittings shall be cleaned, primed with Type B primer and coated with hot-applied coal tar enamel with bonded layer of felt wrap in accordance with AWWA C203. Asbestos felt shall not be used; felt material shall be fibrous glass mat as specified in Appendix Section A2.1 of AWWA C203.
 - 2. Adhesive-thermoplastic Resin Coating: Fed. Spec. L-C-530, Type I.
 - 3. Thermosetting Epoxy Coating: Fed. Spec. L-C-530, Type II.
 - 4. Field-applied plastic tape material used on pipe joints and for repairing damaged areas of shop-applied coatings, Fed. Spec. L-T-1512, Type I, 10 mils nominal thickness for pipe joints, and Type II, 20 mils nominal thickness for coating repairs.

2.5 VALVES

- A. General: Each item shall have threaded or flanged, connections as applicable to match joints specified for its respective service.
- B. Gas Valves:
 - 1. 4 Inches and Smaller: Bronze two piece ball valve, chrome plated ball, CSA & Underwriters Laboratories listed.
 - 2. First-stage gas pressure regulators shall be Fisher Type 621 field regulator, screwed ends, cast iron body, flange type union, suitable for use with liquefied petroleum gas.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General:

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1. Suspended horizontal piping shall be supported by adjustable wrought steel clevis hangers. Where supports bear on copper pipe, they shall be copper plated. Chain, strap, wire or other make-shift devices will not be permitted as hangers or supports. Risers shall be securely supported and braced in an approved manner. Hangers or roof supports for metal piping shall be spaced not over 6 feet apart for pipes 1/2 inch or smaller, 8 feet apart for 3/4 inch pipes and not over 10 feet apart for pipes 1 inch or larger. Hangers shall be located at all changes in direction and at each joint.
2. Install branch piping for gas from the respective piping systems and connect to all valves, cocks, and equipment, including those furnished by the Owner or specified in other sections of these specifications. Approximate locations for roughing-in are shown on the contract drawings. No piping or roughing-in shall be started until data showing exact locations for equipment and connections required are provided by the Architect. This data shall then be used for roughing-in equipment. Individual components not furnished with the equipment, but required for a complete installation, shall be provided under this section of these specifications.
3. Install trim and fittings provided with casework, cabinets, and laboratories, but not installed at point of fabrication.
4. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
5. All pipe runs shall be laid out and scheduled to avoid interferences with other work.
6. Install valves with stem in horizontal position. All valves shall be easily accessible. Isolation valves shall be installed at each major piece of equipment and at other points indicated or required for isolation or sectionalizing purposes. Pipe shall be supported so that weight of pipe is not on valve body.
7. Exterior underground gas piping shall have a minimum of 24 inch cover unless indicated otherwise on drawings.
8. Unions in gas piping shall be ground seat type.
9. Screwed joints for steel pipe shall be made with tapered threads, properly cut and all burrs removed. Pipe ends shall be reamed to full size of bore and all filings removed. Joints shall be made tight with an approved joint cement suitable for the service encountered and applied to the male threads only. A maximum of 3 threads shall show after joint is made up.
10. *Welded joints shall be fusion welded by qualified welders in accordance with ANSI B31.1 Section 6, unless otherwise required. (* Where piping system is 5 psi or higher add the following to paragraph 10: Welding specifications and procedures to be used, API1104, Standard for Welding Pipelines and Related Facilities; AWS B2.1, Standard for Welding Procedures and Performance Qualification; or ASME Boiler and Pressure Vessel Code, Section IX.*) Mitering or notching pipe to form elbows and tees, and drilling or punching to make connections will not be permitted.
11. Gas:

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- a. Install natural gas piping with plugged drip pockets at low points and ahead of the connection to each piece of equipment. Entire gas piping installation shall be in accordance with requirements of Virginia Uniform Statewide Building Code.
 - b. Minimum slope shall be 1/4 inch per fifteen feet in direction opposite flow.
 - d. Installation of gas transmission systems and liquid petroleum pipelines shall obtain a degree of safety performance required by 49 CFR, Part 192 and 195, if applicable.
 - e. Shut-off cock shall be provided at each burner, if not provided with the respective equipment.
 - f. Provide a shutoff valve with test port on upstream and downstream side of all line medium pressure regulators. Downstream test port shall be installed not less than 10 pipe diameters downstream of regulator outlet.
 - g. All natural gas line and appliance regulators exposed to the weather must be rated for outdoor use.
 - h. All natural gas regulators located where unit may be submerged during floods, shall be provided a special anti-flood type breather vent fitting.
- B. Bonding of Gas Piping: All metal gas piping attached to the building shall be bonded in accordance with the requirements of the current edition of NFPA 70, Article 250.104(b) and Section 26 05 26 of the Electrical Specifications.

3.2 TESTS

- A. General: Contractor shall provide all instruments, materials, and labor required. Tests shall be made in the presence of the Owner or Authority having jurisdiction or as otherwise directed by the Architect, who shall be given five (5) days notice by this Contractor of his readiness to perform such tests. Any leaks that develop during the tests shall be repaired by remaking the joint or replacing pipe and fittings. Temporary caulking will not be permitted. No piping shall be concealed until it has been tested, with results acceptable to the Architect.
- B. Gas System: Gas piping shall be tested and inspected in accordance with Virginia Uniform Statewide Building Code.

3.3 CLEANING

- A. Remove trash, plaster, dust, paint spots and all foreign matter from all piping and equipment.
- B. The Contractor shall check each length of pipe before it is put in place to make certain there is not foreign material (stones, sand, etc.) in the systems. Provide temporary bypass around equipment if or as required.

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3.4 REPORTS

- A. Report of cleaning and testing: Contractor shall verify *in writing before completion of the job* that all specified cleaning procedures, tests and sterilizing have been performed, with results as specified or as required by codes.

END OF SECTION 226000

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SECTION 230000 - BASIC HVAC REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes Basic HVAC (Mechanical) Requirements applicable to all Division 23 Sections.

1.2 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.3 MANUFACTURER INSTALLATION INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting and finishing to Architect/Engineer in quantities specified for product data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.4 MANUFACTURER CERTIFICATES

- A. When specified in individual specification sections, submit certification by manufacturer to Architect/Engineer in quantities specified for product data.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect/Engineer.

1.5 REGULATORY REQUIREMENTS

- A. Conform to:
 - 1. The Virginia Uniform Statewide Building Code including referenced codes and standards.
 - 2. Industry Standards, Codes and Specifications:
 - a. ANSI: American National Standards Institute.

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- b. ARI: Air-Conditioning and Refrigeration Institute.
 - c. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.
 - d. ASME: American Society of Mechanical Engineers.
 - e. ASTM: American Society for Testing and Materials.
 - f. AWS: American Welding Society.
 - g. AWWA: American Water Works Association.
 - h. CISPI: Cast Iron Soil Pipe Institute.
 - i. ICC: International Code Council, Inc.
 - j. MSS: Manufacturers Standardization Society of the Valve & Fittings Industry, Inc.
 - k. NAIMA: North American Insulation Manufacturers Association.
 - l. NBS: National Bureau of Standards.
 - m. NFPA: National Fire Protection Association.
 - n. SMACNA: Sheet Metal and Air Conditioning Contractors.
 - o. UL: Underwriters Laboratories, Inc.
 - p. USASI: United States of America Standards Institute.
 - q. VDOT: Virginia Department of Transportation.
- B. Obtain permits and request inspections from authority having jurisdiction.

1.6 PROJECT/SITE CONDITIONS

- A. Install work in locations shown on drawings, unless prevented by project conditions. The drawings show the general arrangement of all piping, ductwork, equipment and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. The work shall conform to the requirements shown on all of the drawings. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, offsets, transitions and other accessories as may be required to meet such conditions.
- B. Prepare drawings showing proposed re-arrangement of work to meet project conditions, including changes to work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.

1.7 PAINTING

- A. Refer to Division 9 - Paints and Coatings: Product and execution requirements for painting specified by this section.
- B. HVAC equipment, related piping, ductwork and materials do not require painting except as indicated below:

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1. Painting is not required for equipment having a factory applied finish except touch-up with matching finish where factory finish is damaged.
 2. Piping (except insulated and jacketed piping), fabricated supports, and any unfinished or unprotected materials located outdoors shall be painted with a suitable primer and compatible finish paint. Color shall be as directed by Architect/Engineer.
 3. Paint inside of ductwork with matte black paint where visible behind air inlets and outlets.
- C. Protection of work: Painting shall be done with care to protect work and work of other trades. All damage caused by the painting operations shall be corrected, repaired and cleaned as required. Hardware, special control items, gages, thermometers, nameplates, instrument glass and other similar items shall be removed or properly protected during the painting operation to ensure that these items are not covered or splattered with paint.

1.8 ELECTRICAL PROVISIONS

- A. Temperature control wiring shall be furnished as part of the Mechanical Work, Section 230900 - INSTRUMENTATION AND CONTROL FOR HVAC. Temperature control wiring is any wiring, regardless of voltage, related to mechanical equipment that is not the equipment power circuit from the circuit breaker in the panelboard to the motor starter or safety disconnect switch and to the motor or equipment junction box. Temperature control wiring shall include, regardless of voltage, power for control panels, power for actuators, signal for input and outputs, interlocks, and line voltage as herein specified to provide the proper operation and sequence of control for all heating, ventilating, and air conditioning equipment. All wiring shall conform to applicable sections of Division 26, 27 and 28 of the specifications.

1.9 WARRANTY

- A. All materials and workmanship shall be warranted to be free from defects for a period of one (1) year from date of acceptance and Contractor shall make good, without additional cost to the Owner, any defects which may appear within that period. Manufacturer's warranties extending beyond one year shall be processed and turned over to the Owner.

1.10 CLOSEOUT PROCEDURES: OPERATION AND MAINTENANCE MANUALS

- A. Comply with requirements of Division 1 Sections and the following requirements.
- B. Submit data on 8-1/2 x 11 inch text pages, bound in three ring binders with durable plastic or cloth covers.

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- C. Prepare binder cover with printed title "Operation and Maintenance Instructions", title or project, and subject matter of binder when multiple binders are required.
- D. Internally subdivide the binder contents with permanent page dividers, logically organized, with minimum content as described below.
- E. Contents:
 - 1. Name of manufacturer.
 - 2. Name, address and telephone number of nearest manufacturer's representative.
 - 3. Copy of latest approved submittal including all review comments.
 - 4. Manufacturer's installation, operation and maintenance instructions including lubrication data.
 - 5. Parts numbers for all replaceable items.
 - 6. Serial numbers of all principal items of equipment.
 - 7. Control diagrams and sequence of operation.
 - 8. Manufacturer's written warranties that extend beyond the Contractor's one year warranty.
- F. Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect/Engineer will return copy with comments.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. Dimensions: The Contractor shall verify that items to be furnished fit the space available. He shall make field measurements to ascertain space requirements, including those for connections and maintenance, and shall furnish and install such sizes and shapes of equipment that the final installation shall suit the true intent and meaning of the drawings and specifications. Should he conclude that there is insufficient space for installation of specified materials, he shall immediately notify the Architect/Engineer of the conflict and shall stop affected work until he receives instructions as to how to proceed from the Architect/Engineer.
- B. When substitution of equipment or materials requires changes or revisions to the arrangement, layout or design of any system, drawings showing these changes or revisions shall be submitted for review, along with other required submittal data. The costs of all such changes and revisions shall be borne by the Contractor.
- C. Similar items shall be provided by a single manufacturer.

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2.2 EQUIPMENT ACCESSORIES

- A. The Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work ready for use, occupancy and operation by the Owner.
- B. Equipment or Connections Different from those Shown: Where equipment requiring different arrangement of connections from those shown is proposed by the Contractor, and is acceptable to the Architect/Engineer, it shall be the responsibility of the Contractor to install the equipment to operate properly and in harmony with the intent of the drawings and specifications. The Contractor shall make all incidental changes in piping, ductwork, supports, insulation, heaters, controls and other associated facilities. He shall provide all additional equipment required for proper operation of the system, including all required changes in affected trades. The Contractor shall be responsible for the proper location of rough-in and connections. All such changes shall be made at no increase in cost to the Owner.
- C. Drives and Belt Guards: The Contractor shall provide for each chain or belt drive, rotating shaft, coupling or other moving parts, a protective guard which shall be securely bolted to the equipment base or apparatus. The guard shall completely enclose all moving parts and be constructed to comply with all safety requirements. For double inlet fans, the belt guard shall be arranged so as not to restrict the air flow into the fan inlet. Guards shall not interfere with lubrication of equipment.
- D. Supports: The Contractor shall support plumb, rigid and true to line all work and equipment furnished. The Contractor shall study thoroughly all general, structural and HVAC (mechanical) drawings, shop drawings and catalog data to determine how equipment, fixtures, piping, ductwork, etc., are to be supported, mounted or suspended and shall provide extra steel bolts, inserts, pipe stands, brackets and accessories for proper support whether or not shown on the drawings. When directed, the Contractor shall submit drawings showing supports for review by the Architect/Engineer.

2.3 ACCESS DOORS

- A. General: Access doors shall be provided for all concealed valves, controls, dampers, damper operators and any other equipment or material requiring inspection or maintenance. Access doors shall be furnished for floors, walls, and ceilings, or adequate size so that the concealed items will be readily accessible for servicing or for removal and replacement if necessary.
- B. Construction: Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware. Except as otherwise indicated, fabricate wall/ceiling

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door units of welded steel construction with welds ground smooth; 16 gage frames and 14 gage flush panel doors, 175 degree swing with concealed spring hinges; flush screwdriver-operated cam locks; factory applied rust inhibitive prime coat paint finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

- A. All equipment and materials specified in this Division shall be installed in accordance with the manufacturer's instructions including, but not limited to, the following:
 - 1. Storage, handling, rigging, and installation shall be accomplished using means and methods recommended by the manufacturer.
 - 2. Location and orientation of equipment shall provide the indicated operation and performance and shall also provide the recommended unobstructed clearances around equipment for maintenance and repair.
 - 3. Provide accessories and incidental materials recommended by the manufacturer.

3.2 COORDINATION

- A. Offsets, transitions and changes in direction in pipes and ducts shall be made as required to maintain proper head room, clearances and pitch of sloping lines whether or not indicated on the drawings. The Contractor shall furnish and install all fittings, traps, drains, air vents, etc., as required to effect these offsets, transitions and changes in direction.
- B. Ductwork: Exact arrangement and routing of ductwork shall be determined at the job site prior to beginning fabrication of any ductwork. The Contractor shall provide offsets and transitions, and shall change the cross-sectional dimensions of ductwork when required to meet job conditions but shall maintain the minimum equivalent cross-sectional area. The Contractor shall secure the approval of the Architect/Engineer prior to fabrication of ductwork requiring such changes.
- C. Drawings by the Contractor: When directed by the Architect/Engineer, the Contractor shall submit for review drawings clearly showing certain portions of the HVAC work and it's relation to the work of other trades before commencing shop fabrication or erection at the project site.

3.3 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project site identified with names, model numbers, types, grades, compliance labels, and other information needed for distinct

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identification; adequately packaged and protected to prevent damage during shipment, storage and handling. Protect stored equipment and materials from damage. Comply with manufacturer's rigging and moving instructions for unloading equipment and moving into final location.

3.4 INSTALLATION OF ACCESS DOORS

- A. Install access doors at all concealed valves, controls, dampers, damper operators, other equipment or materials requiring inspection or maintenance, where indicated and where required by Code, in accordance with manufacturer's written instructions and in compliance with industry practices.
- B. Coordinate with other work, including substrate construction work, as necessary to interface installation of access doors with other work.
- C. Locate each access door accurately in relation to the item requiring access.
- D. Provide adequate temporary support or attachment to framing or formwork such that units will not be dislocated during construction of substrates.
- E. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.
- F. Adjust hardware and panels after installation for proper operation.
- G. Replace panels and frames which are warped or damaged.

3.5 HEATING SYSTEMS START-UP

- A. When the initial start-up of heating systems occurs during cold weather, the Contractor shall provide and operate temporary heating equipment to heat the building, or the appropriate areas within the building, to minimum 55 degrees F prior to the initial heating systems start-up:

3.6 COOLING SYSTEMS START-UP

- A. When the initial start-up of cooling systems occurs during warm weather, the Contractor shall provide and operate portable cooling or dehumidification equipment to reduce the indoor air dewpoint to less than 55 degrees F prior to start-up of the building cooling systems.

END OF SECTION 230000

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

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- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

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1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

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SECTION 230517 - SLEEVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- B. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Install pipe sleeves where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as reviewed by engineer. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4 inch above level floor finish, and 1 inch above floor finish sloped to drain.
 - 1. Sleeves are not required for core-drilled holes.
 - 2. Using grout, seal the space outside of sleeves in slabs.
- C. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

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3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

3.2 SLEEVE SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves, PVC-pipe sleeves.
2. Interior Partitions:
 - a. Galvanized-steel-pipe sleeves or PVC-pipe sleeves.

END OF SECTION 230517

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SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped Type: Steel with chrome-plated finish or stainless steel with polished finish; spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped Type: Steel with chrome-plated finish or stainless steel with polished finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Provide brass or stainless steel escutcheons in wet locations and exterior locations.
- C. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

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1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped type or split-plate, stamped type with concealed hinge or split-plate, stamped type with exposed-rivet hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons using new materials.

END OF SECTION 230518

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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Fastener systems.
4. Roof equipment supports.

- B. Related Sections:

1. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 QUALITY ASSURANCE

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

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PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold and Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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2.4 EQUIPMENT SUPPORTS

- A. Roof Equipment Supports: Refer to description on drawings.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- C. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- I. Insulated Piping:
 - 1. Attach clamps and spacers to piping.

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- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Roof Equipment Supports:

1. Install in accordance with manufacturer's instructions.
2. Attach supports to roof deck or building structure. Secure equipment to supports.
3. Equipment shall be set level. Top of supports shall be level; provide supports with bottom sloped to match pitch of roof or provide shims under bottom of supports.

3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

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3.4 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. 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. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

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1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. 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.
 12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

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- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Ceiling tacks.

1.2 REFERENCES

- A. American Society of Mechanical Engineers
 - 1. ASME A13.1 – Scheme for the Identification of Piping Systems.

1.3 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 AND CONTROL LABELS

- A. Plastic Labels for Equipment and Controls:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, minimum 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black, blue or green.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

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5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.3 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color-coded head.
- B. Color code as follows:
 1. HVAC equipment: Yellow.
 2. Fire dampers/smoke dampers: Red.
 3. Plumbing valves: Green.
 4. Heating/cooling valves: Blue.

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PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT AND CONTROL LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 CEILING TACK INSTALLATION

- A. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article. Provide the name and qualifications of the TAB Field Supervisor assigned to this project.
- B. Certified TAB reports: Furnish reports in letter size binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 1. Include instrument calibration reports. Provide the following:
 - a. Instrument type and make.
 - b. Serial number.

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- c. Application.
- d. Dates of use.
- e. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications:

1. Engage a TAB contractor certified by AABC or NEBB, specializing in testing, adjusting, and balancing of systems specified in this section. The company shall not be affiliated in any way with the contractor, equipment suppliers or installers.
2. Perform Work under on-site supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Adjusting and Balancing Supervisor.
 - a. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
 - b. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Contractor shall meet with TAB Contractor and Owner on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

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1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

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- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine operating safety interlocks and controls on HVAC equipment.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation."

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- C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

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2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

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- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.

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2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.9 TOLERANCES

A. Set HVAC system's air flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Pressure Relationships: Maintain pressure relationships indicated plus or minus 10 percent.
4. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.

3.10 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced.

3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.

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4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

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1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.

2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.

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- d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
- a. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig.
 - j. Refrigerant suction temperature in deg F.
- G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
2. Test Data (Indicated and Actual Values):
- a. Total air flow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.

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- g. Air static-pressure differential in inches wg.
- h. Low-fire fuel input in Btu/h.
- i. High-fire fuel input in Btu/h.
- j. Manifold pressure in psig.
- k. High-temperature-limit setting in deg F.
- l. Operating set point in Btu/h.
- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h.

H. Air to Air Heat Exchanger:

- 1. Unit Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Model number
 - f. Serial number
- 2. Test Data (Indicated and Actual Values):
 - a. Exhaust air flow, design and actual
 - b. Outdoor air flow, design and actual
 - c. Exhaust air pressure drop, design and actual
 - d. Outdoor air pressure drop, design and actual
 - e. Exhaust air inlet DB temperature, design and actual
 - f. Exhaust air inlet WB temperature, design and actual
 - g. Exhaust air outlet DB temperature, design and actual
 - h. Exhaust air outlet WB temperature, design and actual
 - i. Outdoor air inlet DB temperature, design and actual
 - j. Outdoor air inlet WB temperature, design and actual
 - k. Outdoor air outlet DB temperature, design and actual
 - l. Outdoor air outlet WB temperature, design and actual

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.

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- h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- K. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.

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- e. Make.
- f. Number from system diagram.
- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary air flow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final air flow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

L. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.12 INSPECTIONS

- A. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- B. Check the following for each system:
 - 1. Measure airflow of at least 10 percent of air outlets.
 - 2. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - 3. Verify that balancing devices are marked with final balance position.
 - 4. Note deviations from the Contract Documents in the final report.

END OF SECTION 230593

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SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

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1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.
- D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

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1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Eagle Bridges - Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - b. Vimasco Corporation; 713 and 714.

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3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. FSK Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - c. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FACTORY-APPLIED JACKETS

- #### A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

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3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.

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6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, minimum 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, minimum 1/2 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; CHP-1.
 - 2) GEMCO; Cupped Head Weld Pin.

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- 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

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5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
 - 2) GEMCO; Peel & Press.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.

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- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

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- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and

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end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

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4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed and exposed, supply and outdoor air.
2. Indoor return located in unconditioned space such as storage rooms.
3. Indoor, concealed and exposed, exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Supply ducts exposed within the conditioned space:
 - a. Locker rooms and adjoining toilets and showers.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

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3.7 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed duct and plenum insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 2.2 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 1.5 inches thick and 3-lb/cu. ft. nominal density.

- B. Exposed, plenum and rectangular duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 1.5 inches thick and 3-lb/cu. ft. nominal density.

END OF SECTION 230713

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SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping.
 - 2. Refrigerant suction and hot-gas piping.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
 - 1. Submit manufacturer's specifications and installation instructions for each type of mechanical insulation.
 - 2. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each mechanical system requiring insulation.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

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- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000-Degree Pipe Insulation.
 - d. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ramco Insulation, Inc.; Super-Stik.

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- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ramco Insulation, Inc.; Thermokote V.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aero seal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - c. Mon-Eco Industries, Inc.; 22-25.
- D. ASJ and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

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- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - c. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 5. Color: White.

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- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - c. Mon-Eco Industries, Inc.; 55-10.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 4. Service Temperature Range: 0 to plus 180 deg F.
 5. Color: White.

2.6 SEALANTS

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

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- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C. Thickness is indicated in field-applied jacket schedules.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Thickness: 20 mils.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

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- a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water.

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3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.

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2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
- B. Insulation Installation at Interior Wall and Partition: Install insulation continuously through walls and partitions.
- C. Insulation Installation at Floor Penetrations: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints,

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seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Installation shall follow the manufacturer's installation instructions or ASTM C 1710.

B. Insulation Installation on Straight Pipes and Tubes:

1. Slit tubular sections and apply onto piping or tubing. Alternatively, slide un-slit sections over the open ends of piping or tubing.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation must be installed in compression to allow for expansion and contraction.
4. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
5. For below-ambient systems, adhere the insulation to the pipe at least every 18 feet using manufacturer's adhesive. Completely terminate joints at critical points such as flanges, T-sections, elbows, supports, and similar fittings.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. Install mitered sections of pipe insulation.
3. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
3. Install PVC jacket at pipe fittings and elbows.

3.8 FINISHES

- #### A. Flexible Elastomeric Thermal Insulation Installed Outdoors: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended UV protective coating.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- #### A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Condensate Drains:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

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B. Refrigerant Suction and Hot-Gas tubing:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.

END OF SECTION 230719

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SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Division 26 Sections.
- C. Products integrated with the work of this section:
 - 1. Packaged Roof Top Air Conditioning Units.
 - 2. Mini-Split Systems.
 - 3. Supply and Exhaust Fans.

1.3 DEFINITIONS

- A. BACNet: ANSI/ASHRAE Standard 135, BACNet.
- B. DDC: Direct digital control.
- C. I/O: Input/output.
- D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- E. MS/TP: Master slave/token passing.
- F. PC: Personal computer.
- G. PID: Proportional plus integral plus derivative.
- H. RTD: Resistance temperature detector.

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1.4 SCOPE

- A. The Building Automation System/Automatic Temperature Controls (BAS/ATC) systems shall be furnished and installed completely under the BAS/ATC Contract. Control components shall be mounted and wired by the BAS/ATC Contractor.
- B. The engineering, installation, calibration, software programming and graphics, and checkout necessary for complete and fully operational BAS/ATC systems, as specified hereafter, shall be provided by the BAS/ATC Contractor.
- C. The BAS/ATC Contractor shall be responsible for a complete point to point checkout of all system inputs and outputs. This shall be completed, and verification submitted, before functional testing will begin.
- D. The BAS/ATC Contractor shall work with the TAB Contractor during balancing and shall be available to manipulate the systems in order for the TAB Contractor to take readings and adjust at full load. The BAS/ATC Contractor shall provide the TAB Contractor with an interface to the control system (be it a laptop, software or other) in order to balance the systems OR the BAS/ATC Contractor shall accompany the TAB Contractor and manipulate the systems at the TAB Contractor's direction for the duration of balancing.
- E. The BAS/ATC Contractor shall be responsible for demonstrating all sequences of operation for the equipment to the Owner.

1.5 GENERAL INSTRUCTIONS

- A. In general, the BAS/ATC system shall be based on a completely electronic system, fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software and interconnecting wire and conduit.
- B. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, valve and damper actuators.
- C. Provide controls as described in the Sequence of Operation, Points List and Electrical Drawings and Specifications.
- D. Provide control systems consisting of sensors, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.
- E. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system. Installation shall be by qualified employees of the BAS/ATC Contractor or its exclusive authorized representative. Indirect temperature control work by independent contractors will not be accepted.

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- F. All control items except sensors located in finished rooms shall be identified with engraved plastic nameplates permanently attached.
- G. Room sensor locations shall be coordinated to align vertically or horizontally with adjacent light switches or control devices.
- H. BAS/ATC Contractor shall meet with manufacturer's representatives of equipment to be controlled by BAS to coordinate interface of BAS to controlled equipment including sensor types and characteristics, controllers, controller locations, wiring, and communication.
- I. All control wiring in exposed locations shall be in raceway. Control wiring installed above ceilings or concealed inside walls may be open. Refer to Division 26 Specifications.

1.6 CODES AND STANDARDS:

- A. Work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of local, state and federal authorities. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:
 - 1. National Electric Code (NEC)
 - 2. International Building Code (IBC)
 - 3. International Mechanical Code (IMC)
 - 4. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
 - 5. ANSI/ASHRAE Standard 135 (BACnet)

1.7 SEQUENCE OF OPERATION:

- A. Refer to sequence of operation and point list on drawings.

1.8 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

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2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

1.9 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 5. Calibration records and list of set points.
- B. Software and Firmware Operational Documentation: Include the following:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Software license required by and installed for DDC workstations and control systems.

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1.10 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.11 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.

1.12 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Section 283100 "Fire-Alarm" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Section 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

- A. Manufacturer: Instrumentation and control for HVAC shall be an extension of the Owner's existing Trane Tracer Summit System, no substitutions.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- C. Materials: All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 1 year. The installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing. Spare parts shall be available for at least 5 years after completion of this contract.

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2.2 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
- C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
- D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
 - 3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on

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network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.4 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 1. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
 2. Wire: Twisted, shielded-pair cable.
 3. Insertion Elements in Ducts: Single point, use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 4. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
 5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
 6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- C. RTDs and Transmitters:
 1. Accuracy: Plus or minus 0.2 percent at calibration point.
 2. Wire: Twisted, shielded-pair cable.
 3. Insertion Elements in Ducts: Single point, Use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 4. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
 5. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- D. Humidity Sensors: Bulk polymer sensor element.
 1. Accuracy: 5 percent full range with linear output.
 2. Room Sensor Range: 20 to 80 percent relative humidity.
 3. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
 5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure.

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E. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
 - d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
2. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
3. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.5 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
- B. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- C. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- D. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- E. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- F. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

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2.6 GAS DETECTION EQUIPMENT

- A. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

2.7 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.
- C. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.2 PROTECTION:

- A. The Contractor shall protect all work and material from damage by his/her work 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 his/her work against theft or damage and shall carefully store material and equipment received on site 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.

3.3 GENERAL WORKMANSHIP:

- A. Install equipment, piping, wiring/conduit parallel to System 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.

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- C. Install all equipment in readily accessible location as defined by chapter 1, article 100, part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- 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.

3.4 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 Section.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to System lines and properly supported.
- C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.5 WIRING:

- A. Install raceways, boxes, and cabinets according to Section 260533 "Raceway and Boxes for Electrical Systems".
- B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
- C. Install signal and communication cable:
 - 1. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 2. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 3. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 4. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

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- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- F. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications.
- G. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
 - 1. Circuits meet NEC Class 2 (current limited) requirements. (Low voltage power circuits shall be sub fused when required to meet Class 2 current limit.)
 - 2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
- H. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- I. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.
- J. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. 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 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.
- L. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- M. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
- N. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.
- O. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

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- P. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- Q. Adhere to Section 260533 "Raceway and Boxes for Electrical Systems" for installation of raceway.
- R. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as built) wiring diagrams with terminations identified at the job site.
- S. Flexible metal conduits and liquid tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid tight, flexible metal conduits shall be used.

3.6 INSTALLATION OF SENSORS:

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequate for the environment within which the sensor operates.

3.7 WARNING LABELS:

- A. Affix labels on each starter and equipment automatically controlled through the DDC System. Warning label shall indicate the following:
- B. Affix labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects. Labels shall indicate the following:

3.8 IDENTIFICATION OF HARDWARE AND WIRING:

- A. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."
- B. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum 1/2" letters on nameplates.

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- E. Identify all other control components with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.9 PROGRAMMING:

- A. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- B. Provide programming for the system as written in the specifications and adhere to the sequence strategies provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into any custom-written control programs sufficient comment statements or inherent flow diagrams to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- C. Operators' Interface
 - 1. Standard Graphics. Provide graphics for each major piece of equipment in the System. These standard graphics shall show all points dynamically as specified in the points list.
 - 2. The controls contractor shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.
 - 3. As part of this execution phase, the controls contractor will perform a complete test of the operator interface. Test duration shall be a minimum of 16 hours on-site. Tests shall be made in the presence of the Owner or Owner's representative.
- D. Demonstration: A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed. The contractor shall dedicate a minimum of 8 hours on site with the Owner and his representatives for a complete functional demonstration of all the system requirements. This demonstration constitutes a joint acceptance inspection, and permits acceptance of the delivered system for on line operation.

3.10 CLEANING:

- A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

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- B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making 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 metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.11 TRAINING:

- A. Train the designated staff of Owner's representative and Owner to enable them to proficiently operate the system and perform routine diagnostic and troubleshooting procedures.

3.12 ADJUSTING:

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

B. Flow:

1. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
2. Manually operate flow switches to verify that they make or break contact.

C. Pressure:

1. Calibrate pressure transmitters at 0, 50, and 100 percent of span.

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2. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- D. Temperature:
1. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 2. Calibrate temperature switches to make or break contacts.
- E. Provide diagnostic and test instruments for calibration and adjustment of system.
- F. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- G. Adjust initial temperature set points.

END OF SECTION 230900

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SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Condensate-drain piping.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type M.
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Wrought-Copper Unions: ASME B16.22.

2.2 PLASTIC PIPE AND FITTINGS

- A. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.
 - 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.3 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Solvent Cements for Joining Plastic Piping:
 - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

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PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Condensate-Drain Piping: Type M or Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- K. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

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3.3 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 3. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
- D. Plastic Piping Hanger Spacing: Space hangers according to building code requirements.

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.

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3.5 FIELD QUALITY CONTROL

A. Perform the following tests on hydronic piping:

1. Equipment drains and overflow piping shall be tested by filling with ambient temperature water after plugging all openings. The test shall be conducted for a period of time sufficient to inspect every joint in the system but not less than 15 minutes. No loss of water will be allowed.

END OF SECTION 232113

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SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

1.4 QUALITY ASSURANCE

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

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PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

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- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Solvent-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Base: Synthetic rubber resin.
 - 3. Solvent: Toluene and heptane.
 - 4. Solids Content: Minimum 60 percent.
 - 5. Shore A Hardness: Minimum 60.
 - 6. Water resistant.
 - 7. Mold and mildew resistant.
 - 8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 - 9. Service: Indoor or outdoor.
 - 10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

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2.4 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

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- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- K. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

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3.3 DUCT SEALING

- A. Seal ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 1. Seal Class A.
 2. Sealant is not required on ducts of 1-inch wg pressure class and less that are exposed in the conditioned space.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

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- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.7 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Fan Coil Units and supply fans:
 - a. Pressure Class: Positive 1-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Packaged Roof Top Air Conditioning Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.

B. Return Ducts:

1. Ducts Connected to Fan Coil Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Packaged Roof Top Air Conditioning Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.

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C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Packaged Roof Top Air Conditioning Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.

D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units:
 - a. Pressure Class: Positive 1-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. SMACNA Leakage Class for Rectangular: 12.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

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G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.

END OF SECTION 233113

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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Turning vanes and air extractors.
2. Flexible connectors.
3. Duct-mounted access doors.
4. Manual volume dampers.
5. Control dampers (motor operated dampers).
6. Insulated flexible ducts.
7. Duct accessory hardware.

1.3 ACTION SUBMITTALS

- A. Product Data for the following items:

1. Duct-mounted access doors.
2. Manual volume dampers.
3. Control dampers (motor operated dampers).
4. Insulated flexible ducts.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

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PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

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- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.
- E. Air Extractors: Air extractors shall be constructed of aluminum or galvanized steel, with curved deflection vanes on 2 inch centers, and attached to pivoting frame and bracket. Provide push-pull operator strap.

2.4 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cain Manufacturing Co., Inc.
 - 2. Ductmate Industries, Inc.
 - 3. Duro Dyne Inc.
 - 4. Elgen Manufacturing.
 - 5. Ventfabrics, Inc.
 - 6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.5 DUCT-MOUNTED ACCESS DOORS

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

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1. Ruskin Company.
 2. Cesco Products; a division of Mestek, Inc.
 3. Air Balance, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges or continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges or continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges or continuous and two compression latches with outside and inside handles.

2.6 MANUAL VOLUME DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ruskin Company.
 2. Cesco Products; a division of Mestek, Inc.
 3. Air Balance, Inc.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Rectangular Dampers: Ruskin model MD-35.
1. Frame: 16 gage galvanized steel.
 2. Blades: 16 gage galvanized steel.
 3. Axles: ½ inch plated steel hex.

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4. Linkage: Concealed in frame.
5. Single Blade Damper: Fabricate for duct sizes up to 10 x 48 inches.
6. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in galvanized frame channel with suitable hardware.
7. End Bearings: Nylon or oil-impregnated sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg.

D. Round Dampers 20 inch diameter and smaller: Ruskin model MDRS25.

1. Frame and blade: 20 gage galvanized steel.
2. Axle: 3/8 inch steel.
3. End Bearings: Molded synthetic.

E. Round Dampers larger than 20 inch diameter: Ruskin model CDRS82.

1. Frame: 12 gage galvanized steel.
2. Blade: 16 gage galvanized steel.
3. Axle: 1/2 inch continuous plated steel for 24 inch diameter and smaller; 3/4 inch for dampers larger than 24 inch diameter.
4. End Bearings: Stainless steel.

F. Quadrants: Young Regulator Co. model 404 or model 404B.

1. Furnish locking, indicating quadrant operators on single and multi-blade dampers.
2. On insulated ducts mount quadrant operators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.7 CONTROL (MOTOR OPERATED) DAMPERS

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

1. Ruskin Company model CD35.
2. Cesco Products; a division of Mestek, Inc.
3. Air Balance, Inc.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

1. Frame: 16 gage galvanized steel.
2. Blades: 16 gage galvanized steel, 6 inch width.
3. Axles: 1/2 inch plated steel hex.
4. Linkage: Concealed in frame.

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5. Bearings: Synthetic.
6. Seals: PVC coated polyester fabric blade seals; flexible metal compression edge seals.

C. Damper Operators:

1. General: Provide spring return for two position control and for fail safe operation.
2. Provide a 120V operator for each damper.

2.8 INSULATED FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc., Type 9M.
2. ATCO Rubber Products, Inc. #036.
3. Thermaflex model MK.

B. Product Description: UL 181, Class 1 air duct, polyester, nylon or coated fiberglass fabric liner supported by helical wound spring of galvanized or coated steel wire; fiberglass insulation; reinforced metalized polyester outer jacket.

1. Pressure Rating: 4 inches wg positive and ½ inch wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -20 degrees F to 250 degrees F.
4. Thermal Resistance: 6.0 square feet-hour-degree F per BTU.
5. Maximum flame spread rating = 25; maximum smoke developed rating = 50.
6. Vapor transmission rating: 0.1 perm (maximum).
7. Connections to rectangular ductwork: Straight spin collar fitting with damper and locking operator.

2.9 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

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- B. Set dampers to fully open position before testing, adjusting, and balancing.
- C. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Downstream from manual volume dampers, control dampers, and equipment.
 - 2. Control devices requiring inspection.
- D. Install access doors with swing against duct static pressure.
- E. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- F. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- G. Install flexible connectors to connect ducts to equipment.
- H. Connect diffusers to ducts directly.
- I. Connect insulated flexible ducts to metal ducts with as recommended by manufacturer.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

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SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Downblast centrifugal roof fans.
 - 2. Prefabricated roof curbs.
 - 3. Cabinet fans.
 - 4. Ceiling fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in operation and maintenance manuals.

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1.6 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. Belts: One set(s) for each belt-driven unit.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
 - 1. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
 - 3. Balance Quality: Conform to AMCA 204.
- C. UL Standards: Power ventilators shall comply with UL 705.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 DOWNBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. PennBarry.

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- B. Fan Unit: Downblast type. V-belt or direct drive as indicated in equipment schedule, with spun aluminum housing; resilient mounted motor; aluminum or galvanized steel wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Open drip proof.
- E. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor, NEMA 1 enclosure.
- F. Motor Operated Damper: Aluminum multiple blade construction, felt edged blades, nylon bearings, blades linked and line voltage motor drive, power open, spring return.

2.2 PREFABRICATED ROOF CURBS

- A. Manufacturers: Greenheck Model GPI, model GPIP, or equivalent product by the following:
 - 1. Loren Cook Company.
 - 2. PennBarry.
- B. Construction: Minimum 0.063 inch thick aluminum, with continuous welded and mitered corner seams, to form a rigid and leak-proof shell. Two inch wall thickness, rack or flange to support dampers, treated wood nailer 1 1/2 inch thick, 3 pound density rigid mineral fiberboard insulation with metal liner, built-in cant strip. Curbs shall be built for pitched roof as required to keep top of curb level.
- C. Dimensions: Curb height shall be minimum 12 inches above the top of the roofing system. Perimeter dimensions shall match equipment.

2.3 CABINET FANS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. PennBarry.
- B. Type: Duct mounted supply, exhaust or return fans shall be of the centrifugal, belt driven, inline type. The fan housing shall be of the rectangular design constructed of heavy gauge galvanized steel and shall include rectangular duct mounting collars.

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C. Construction:

1. A hinged or removable panel shall be provided in the fan cabinet of sufficient size to permit access for service to all of the fan's internal components without dismantling the cabinet.
2. The fan wheel shall be of the galvanized steel, forward curved, centrifugal type. Wheels shall be dynamically and statically balanced.
3. shaft shall be ground and polished steel mounted in permanently sealed pillow block bearings. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulleys shall be adjustable for final system balancing.
4. All fans shall bear the AMCA Certified Ratings Seal for Air Performance.
5. Filter Boxes - Constructed of galvanized steel. Available with either a sloped filter arrangement or vertical slide-out. Smaller fan sizes (106, 107, 206 and 207) have a sloped single angled filter. The doublevee configuration is used with all larger sloped sizes. Filters are available in 1 or 2-inch disposable media or permanent, washable aluminum mesh. Filter boxes with slide-out have 2-inch washable aluminum filters.

2.4 CEILING FANS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Greenheck Fan Corporation.
 2. Loren Cook Company.
 3. PennBarry.
- B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity back-draft damper in discharge opening, integral outlet duct collar.
- C. Disconnect: Cord and plug in housing for thermal overload protected motor.
- D. Grille: Molded white plastic or aluminum with baked white enamel finish.
- E. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.
- F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection.

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2.5 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.6 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods. Provide vibration isolators as specified or as indicated on the drawings.
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

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- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Specifications.
- D. Connect wiring according to Division 26 Specifications.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.

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- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 233423

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SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

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. Diffusers, registers, grilles and accessories.
2. Louvers.

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

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PART 2 - PRODUCTS

2.1 DIFFUSERS, REGISTERS AND GRILLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Price Industries.
 - 2. Metal Industries, Inc.
 - 3. Tuttle & Bailey.
- B. Diffusers, registers and grilles shall be the type, material, air pattern, and finish indicated on the drawings. Performance including throw and noise generated shall be equivalent to the indicated devices or as approved.
- C. Provide accessories indicated on drawings.

2.2 LOUVERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ruskin Manufacturing model ELF375DX.
 - 2. Arrow United Industries.
 - 3. Greenheck Corp.
- B. Louvers shall be the type, material, and finish indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers and grilles in accordance with manufacturer's instructions.
- B. Install diffusers, registers, and grilles level and plumb.

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- C. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- E. Paint visible portion of ductwork behind air outlets and inlets matte black.
- F. Provide safety chain attaching the core of each diffuser, register and grille to the inside of ductwork. Provide in Wrestling/Softball/Baseball 200.
- G. Install louvers in accordance with manufacturer's instructions.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 233713

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SECTION 234300 – AIR PURIFICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Air Purification Systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, furnished specialties; and accessories for each model indicated.
- B. Manufacturers other than the Basis of Design Manufacturer shall include in their submittal documentation that demonstrates compliance with all product requirements specified herein.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Provide installation, operation and maintenance data to include in Operation, and Maintenance Manuals.

1.5 QUALITY ASSURANCE

- A. The Air Purification System shall be a product of an established manufacturer within the USA.
- B. Technologies that do not address gas disassociation such as UV Lights, Powered Particulate Filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. “Plasma” particulate filters shall not be acceptable.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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- D. The Air Purification System shall have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. Manufacturers that achieved UL 867 prior to December 21, 2007 and have not been tested in accordance with the newest UL 867 standard with the ozone amendment shall not be acceptable. All manufacturers shall submit their independent UL 867 test data with ozone results to the engineer during the submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.
- E. The maximum allowable ozone concentration per the UL 867-2007 chamber test shall be 0.007 PPM. The maximum peak ozone concentration per the UL 867-2007 peak test as measured 2 inches away from the electronic air cleaner's output shall be no more than 0.0042 PPM. Manufacturers with ozone output exceeding these ozone values shall not be acceptable.
- F. Comply with ASHRAE Standards 52 and 62.
- G. Comply with NFPA 90A and NFPA 90B.
- H. Comply with UL 867.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.
- B. Store in original cartons and protect from weather and construction work traffic.
- C. Store indoors and in accordance with the manufacturers' recommendation for storage.

PART 2 - PRODUCTS

2.1 AIR PURIFICATION SYSTEMS

- A. Description: Factory-fabricated needlepoint bi-polar ionization air treatment systems.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide equipment manufactured by Global Plasma Solutions.
- C. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.

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- D. The Bi-polar Ionization system shall be capable of:
1. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
 2. Controlling gas phase contaminants generated from human occupants, building structure and furnishings.
 3. Capable of reducing static space charges.
 4. Increasing the interior ion levels, both positive and negative, to a minimum of 800 ions/cm³ measured 5 feet from the floor.
 5. Self-cleaning requiring no maintenance or replacement parts.
- E. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable.
1. Air exchange rates may vary through the full operating range of a constant volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
 2. Velocity Profile: The air purification device shall not have maximum velocity profile.
- F. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.
- G. Equipment Requirements: Electrode Specifications (Bi-polar Ionization):
1. Each Plasma Generator with Bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. A minimum of one electrode pair per 4,800 CFM of air flow shall be provided. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion.
 2. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating. Electrodes shall be made from carbon fiber to prevent oxidation over time. Internal circuitry shall be provided to sense air flow across the electrode output. Ionization systems requiring the use of a mechanical air pressure switch to cycle the electrodes only when the fan is operating shall not be acceptable due to high failure rates and pressure sensitivity.
 3. Electrode pair shall provide a minimum of 200 million ions per cubic centimeter as measured at 2 inches, both positive and negative ions, in equal quantities. Devices providing less than 200 million ions/cc per electrode pair shall not be acceptable.
 4. Each Plasma Generator shall be provided with a self-cleaning system that is field programmable to change the number of days between the cleaning cycle. Systems without a no-maintenance, self-cleaning system shall not be acceptable.

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5. Each electrode pair shall be designed with a banana style plug such that it can be field replaced if necessary.
 6. Each Plasma Generator shall be provided with an inline on/off switch, universal voltage input (24VAC to 240VAC or DC), magnets for mounting to the fan inlet, replaceable carbon fiber emitters and a programmable self-cleaning system.
- H. Air Handler & Plenum Mounted Units (non-ductless mini-split units): Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the AHU control power (24VAC) as instructed by the Air Purification Manufacturer's instructions or line voltage subject to power available. Each unit shall be designed with a molded casing, self-cleaning system, self-cleaning test button, power status LED and dry contacts to prove ion output is operating properly. The dry contacts shall close to prove the ion generator is working properly and may be daisy chained in series such that only one dry contact per AHU is required to interface to the BAS or the optional DDC controller. Dry contacts proving power has been applied in lieu of the ion output is actually operating, are not acceptable. Manufacturers providing multiple ion modules that have alarm status wired in parallel, and not in series, shall not be acceptable.
- I. Ionization Requirements:
1. Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.
 - a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and integral power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be cable of accepting 24V to 240V AC or DC voltage and regardless of voltage the high voltage output shall not vary more than 1%. Ionization systems requiring isolation transformers shall not be acceptable.
 - b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable.
 - c. Ionization output from each electrode shall be a minimum of 200 million ions/cc when tested at 2" from the ionization generator.
 - d. Manufacturer shall provide documentation by an independent NELAC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:
 - 1) SARS-CoV-2: 99.4% in 30 minutes or less
 - 2) MRSA: 96% in 30 minutes or less
 - 3) E.coli: 99% in 15 minutes or less
 - 4) TB: 69% in 60 minutes or less
 - 5) C. diff: 86% in 30 minutes or less

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- e. Manufacturer not providing the equivalent space kill rates shall not be acceptable. Manufacturer shall provide to the engineer independent test data from a NELEC accredited independent lab confirming kill rates and time meeting the minimum requirements stated above. Products tested only on Petri dishes to prove kill rates shall not be acceptable.
- 2. Ozone Generation: The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation. There shall be no ozone generation during any operating condition, with or without airflow.
- J. Electrical Requirements: Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 24VAC to 240VAC, universal 2 wire input, 1 phase, 50/60 Hz. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.
- K. Control Requirements:
 - 1. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset circuit breakers. Systems with manual fuses shall not be allowed.
 - 2. All Plasma devices shall have a means to interface with the BAS system. Dry contacts shall be provided to prove there are ions being produced. Systems providing indication that power is applied to the Plasma device, but not directly sensing the power at the ion output, shall not be acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturer's published instructions.
- B. Any material damaged by handling, water or moisture shall be replaced by the contractor at no cost to the owner.
- C. All equipment shall be protected from dust and damage throughout construction.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.

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3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the air purification equipment.

END OF SECTION 234300

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SECTION 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Heat-pump refrigeration components.
 - 3. Hot-gas reheat.
 - 4. Gas furnace.
 - 5. Economizer outdoor- and return-air damper section.
 - 6. Integral, space temperature controls.
 - 7. Roof curbs.
- B. Related Sections include the following:
 - 1. Section 23 07 13 "Duct Insulation".
 - 2. Section 23 09 00, "Instrumentation And Controls For HVAC".
 - 3. Section 23 31 13, "Metal Ducts".

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

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- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of filters for each unit.

1.7 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

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3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
 - C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
 - D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
 - E. UL Compliance: Comply with UL 1995.
 - F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- 1.8 WARRANTY
- A. Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide equipment manufactured by The Trane Company or a comparable product by one of the following:
 1. Daikin.
 2. YORK International Corporation.

2.2 PACKAGED ROOF TOP AIR CONDITIONING UNIT RT-1

- A. General
 1. The unit shall be either field convertible (OAB) or configured at the factory (OAG) between Down/Horizontal discharge for both Supply and Return Openings. Cooling performance shall be rated in accordance with ARI testing procedures.
 2. All units shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance to UL 1995/CAN/CSA No. 236-M40 for Central Cooling Air Conditioners. Canadian units shall be CSA Certified.

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B. Casing

1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 1000 hours in a salt spray test in compliance with ASTM B117. Unit shall have a 2 inch thick Antimicrobial Insulation. All insulation edges shall be either captured or sealed. The unit's base pan shall have no penetrations within the perimeter of the curb other than the raised downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up.

C. Unit Top

1. The top cover shall be one piece construction or, where seams exist, it shall be double-hemmed and gasket-sealed. The ribbed top adds extra strength and enhances water removal from unit top

D. Sensors

1. A factory installed combination outdoor air sensor located in the outdoor air hood is designed to sense both outdoor air temperature and relative humidity for use by the microprocessor controller to make required ventilation, cooling, dehumidification and heating decisions. Refer to the Sequence of Operations section of the Installation, Operation and Maintenance manual for detailed unit control and operational modes. A factory installed sensing tube is designed to sense the supply air temperature downstream of the indoor fan section.

E. Evaporator Coil: Dx 4 Row Interlaced

1. Internally finned, 5/16 inch copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil shall be leak tested to 500 psig and pressure tested to 500 psig. A Stainless Steel double-sloped condensate drain pan with provision for through the unit wall condensate drain is standard. Evaporator coil will have 4 interlaced rows for superior sensible and latent cooling.

F. Hot Gas Reheat: Modulating

1. This option shall consist of a modulating hot-gas reheat coil located on the leaving air side of the evaporator coil prepiped and circuited with a low pressure switch. Refer to the Sequence of Operations section of the Installation, Operation and Maintenance manual for detailed unit control and operational modes.

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- G. Compressor: Variable Speed Scroll-1st Circuit Only
1. All units shall have direct-drive, Variable Speed scroll type compressors with positive displacement oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. The compressor shall be powered and protected by the variable frequency drive (VFD). The VFD shall include all necessary controls for safe operation, startup, and controlled shutdown of compressor. Stator heat shall be used in place of crankcase heaters. Compressor shall be able to modulate from 1000 RPM to maximum speed for the specified cabinet and tonnage.
- H. Condenser: Air Cooled Variable Speed Head Pressure Control
1. (Fin and Tube Coil) - Internally finned, 5/16 inch copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure the pressure integrity. The condenser coil shall be leak tested to 500 psig and pressure tested to 500 psig. The condenser coil shall have a fin design with slight gaps for ease of cleaning. Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electroplated motor mounting brackets. Fans shall be statically and dynamically balanced. Condenser fans to be controlled via VFD to maintain adjustable pressure to increase reheat capacity where applicable and low ambient control.
- I. Indoor Blower Motor: Ecm W/ Backward Curved Plenum Fan
1. Supply Fan shall be a high efficiency backward curved impeller. The supply motor shall be an electronic commuted motor with integrated power electronics.
- J. 439 Stainless Steel Furnace: 200 Mbtu/H, (10:1 Turndown Ng, 8:1 Turndown Lp)
1. Primary heat is supplied using indirect fired gas heating. The heating section shall have a progressive tubular heat exchanger design using Stainless Steel burners and type 439 Stainless Steel tubes. An induced draft combustion blower shall be used to pull the combustion products through the firing tubes. The heater shall use a direct spark ignition (DS) system. On initial call for heat, the combustion blower shall purge the heat exchanger for 20 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat/zone sensor. Units shall be comply with the California requirement for low NOx emissions. Unit shall be suitable for use with Natural Gas. Minimum incoming gas pressure of 7" W.C. and Maximum pressure of 14" W.C. required. Factory provided 25 year heat exchanger warranty.
- K. Unit Controls: Trane UC600 - Space Control W/Bacnet W/Display
1. Unit is completely factory wired with necessary controls and contactor pressure lugs for power wiring. Units will provide an external location for mounting fused

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disconnect device. Micro-processor controls are provided for all 24 volt control functions. The resident control algorithms will make all heating, cooling and/or ventilating decisions in response to electronic signals from sensors measuring outdoor temperature and humidity as well as indoor temperature. The control algorithm maintains accurate temperature control, minimizes drift from set point and provides better building comfort. A centralized micro-processor (OACM) will provide anti-short cycle timing for a higher level of machine protection. Terminals are provided for a field installed dry contact or switch closure to put the unit in the Occupied or Unoccupied modes.

- L. Powered Exhaust: ECM W/ Backward Curved Plenum Fan W/Isolation Dampers
 - 1. Supply Fan shall be a high efficiency backward curved impeller. The supply motor shall be an electronic commuted motor with integrated power electronics.

- M. Energy Recovery & Conservation: ERC-4136c
 - 1. Energy recovery wheel performance shall be AHRI 1060 certified and bear the AHRI certified label. The rotating wheel heat exchanger is composed of a rotating cylinder in an insulated cassette frame complete with removable energy transfer media, seals, drive motor and drive belt. Energy transfer media shall be constructed of a durable synthetic lightweight polymer. The total energy recovery wheel is coated with a desiccant that shall be either Type-A silica gel or 3A molecular sieve and permanently bonded to the energy transfer media without the use of binders or adhesives. The lightweight polymer substrate will not degrade nor require additional coatings for application in marine or coastal environments. Coated segments are cleanable outside of the cabinet with detergent or alkaline coil cleaner and water. Desiccant will not dissolve nor deliquesce in the presence of water or high humidity.

- N. Damper Options: 2-Position Outdoor Air Damper - Class 1a
 - 1. The unit shall have a factory installed and integrated 100% outdoor air hood with Class 1A rated damper controlled by a direct coupled actuator and 2 inch permanent and washable aluminum mesh filters accessible through a hinged access panel. The return air damper tray is blocked off to allow 100% outdoor airflow.

- O. Filters: MERV-8
 - 1. Aluminum Mesh Filters (D, K and N Cabinets) and Galvanized Mesh Bird Screen (B and G Cabinets) shall be installed on the intake of the unit. In addition, one row of 2 inch MERV-8 rated filters (30 percent) shall be installed prior to the evaporator coil. Unit shall be equipped with a filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the attached selection.

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P. Electrical Options: Non-Fused Disconnect Switch W/ 115v Outlet (B/G)

1. A 3-pole, molded case, HACR circuit breaker with provisions for through the base electrical connections shall be installed. The disconnect switch will be installed in the unit in a water tight enclosure. Wiring will be provided from the switch to the unit high voltage terminal block. The switch will be UL/CSA agency recognized. The disconnect switch will be sized per NEC and UL guidelines but will not be used in place of unit overcurrent protection. A powered 120 volt, 10 amp, 2 plug convenience outlet shall be factory installed. A service receptacle disconnect shall be installed. The convenience outlet is powered from the line side of the disconnect or circuit breaker, and therefore will not be affected by the position of the disconnect or circuit breaker. Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically.
 - a. 1. Phase Unbalance Protection: Factory set 2%
 - b. 2. Over/Under/Brown Out Voltage Protection: +/-10% of nameplate voltage
 - c. 3. Phase Loss/Reversal

Q. Accessories: Condenser Hail Guard

1. Hail guards shall be installed on the outside of the condenser coil. The guards shall consist of perforated metal, of the same gauge and color as the unit itself. Airflow through the hail guards shall not be restricted due to location or size of the perforations. Guards shall be removable to accommodate coil cleaning.

2.3 PACKAGED ROOF TOP AIR CONDITIONING UNIT RT-2

A. General

1. The units shall be dedicated downflow airflow. The operating range shall be between 115°F and 0°F in cooling as standard from the factory for all units. Cooling performance shall be rated in accordance with ARI testing procedures. All units shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation and control sequence, before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be UL listed and labeled, classified in accordance to UL 1995/C22.2, 236-05 3rd Edition.
2. Packaged Rooftop units cooling, heating capacities, and efficiencies are AHRI certified within scope of AHRI Standard 340/360 (I-P) and ANSIZ21.47 and 10 CFR Part 431 pertaining to Commercial Warm Air Furnaces (gas heating units).

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B. Casing

1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 672 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit. In order to ensure a water and air tight seal, service panels shall have lifting handles and no more than three screws to remove. All exposed vertical panels and top covers in the indoor air section shall be insulated with a 1/2 inch, 1 pound density foil-faced, fire-resistant, permanent, odorless, glass fiber material. The base of the downflow unit shall be insulated with 1/2 inch, 1 pound density foil-faced, closed-cell material. The downflow unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 1 1/8 inch high supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting.

C. Unit Top

1. The top cover shall be one piece, or where seams exist, double hemmed and gasket sealed to prevent water leakage.

D. Filters

1. Two inch standard filters shall be factory supplied on all units

E. Compressors

1. Unit shall have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of nameplate voltage. Internal overloads shall be provided with the scroll compressors. Compressors shall have crankcase heaters, phase monitors and low and high pressure control as standard.

F. Crankcase Heaters

1. These band heaters shall provide improved compressor reliability by warming the oil to prevent migration during off-cycles or low ambient conditions.

G. Refrigerant Circuits

1. Each refrigerant circuit shall have service pressure ports, and refrigerant line filter driers factory installed as standard. An area shall be provided for replacement suction line driers.

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H. Evaporator And Condenser Coils

1. Evaporator Coils -Microchannel evaporator coils shall be burst tested by the manufacturer. Internally finned, 5/16" copper tubes mechanically bonded to a configured aluminum plate fin shall be standard for evaporator coils. Coils shall be leak tested to ensure the pressure integrity. The evaporator coil shall be leak tested to 225 psig and pressure tested to 450 psig.
2. Condenser Coils - Microchannel condenser coils shall be standard on all units. Coils shall be leak tested to ensure the pressure integrity. The condenser coil shall be leak tested to 225 psig and pressure tested to 450 psig.

I. Gas Heating Section

1. The heating section shall have a drum and tube heat exchanger design using corrosion resistant steel components. A forced combustion blower shall supply premixed fuel to a single burner ignited by a pilotless hot surface ignition system.
2. In order to provide reliable operation, a negative pressure gas valve shall be used on standard furnaces and a pressure switch on furnaces with modulating heat that requires blower operation to initiate gas flow. On an initial call for heat, the combustion blower shall purge the heat exchanger 45 seconds before ignition.
3. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat. Units shall be suitable for use with natural gas shall also comply with California requirements for low NOx emissions.

J. Condenser Coil

1. The microchannel type condenser coil is standard for the standard efficiency models. Due to flat streamlined tubes with small ports, and metallurgical tube-to-fin bond, microchannel coil has better heat transfer performance. Microchannel condenser coil can reduce system refrigerant charge by up to 50% because of smaller internal volume, which leads to better compressor reliability. Compact all-aluminum microchannel coils also help to reduce the unit weight. All-aluminum construction improves re-cyclability. Galvanic corrosion is also minimized due to all aluminum construction. Strong aluminum brazed structure provides better fin protection. In addition, flat streamlined tubes also make microchannel coils more dust resistant and easier to clean. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 600 psig. The assembled unit shall be leak tested to 465 psig.

K. Outdoor Fans

1. The outdoor fan shall be direct-drive, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motor(s) shall be permanently lubricated and shall have built-in thermal overload protection.

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L. Indoor Fan

1. Units above shall have belt driven, FC centrifugal fans with adjustable motor sheaves. Motor shall be thermally protected. Indoor fan motor meet the U.S. Energy Policy Act of 1992 (EPACT).

M. Single Zone VAV - One Zone Variable Air Volume Mode

1. Provide single zone VAV control to match fan speed with cooling and heating loads to provide an optimized balance between zone temperature control and system energy savings.

N. Variable Frequency Drive

1. Variable Frequency Drives shall be factory installed and tested to provide supply fan motor speed Modulation. Bypass control shall provide full nominal airflow in the event of drive failure.

O. Controls

1. Unit shall be completely factory wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device. ReliaTel controls shall be provided for all 24 volt control functions. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point, and provides better building comfort. A centralized control shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.

P. Zone Sensor

1. Provide a wall mounted zone sensor to interface with ReliaTel.

Q. CO2 Sensor

1. Provide a wall mounted CO2 sensor to monitor the concentration (parts per million, ppm) of CO2 (Carbon Dioxide) in the air. As the CO2 concentration changes, the outside air damper shall modulate to meet the current ventilation needs of the zone; refer to Sequence of Operation on drawings.

R. High Pressure Cutout

1. Provide a high pressure cutout.

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S. Modulating Gas Heat

1. The heating section shall have a drum and tube heat exchanger design using stainless steel components. A variable speed forced combustion blower shall supply premixed fuel to a single burner ignited by a pilotless hot surface ignition system. The leaving air temperature shall be communicated to the unit controls (ReliaTel) via a discharge air sensor. This information along with the space temperature will be used to modulate the heating output.
2. In order to provide reliable operation, a pressure switch will require blower operation to initiate gas flow.
3. On an initial call for heat the combustion blower shall purge the heat exchanger 45 seconds before ignition. The heat exchanger will operate at full fire initially and then modulate down to match the desired discharge air temperature. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset.
4. Units shall be suitable for use with natural gas.

T. Low Leak Economizer

1. Economizer shall meet low leak requirements for ASHRAE90.1, IECC, and Title 24 standards; Allows 100 percent outdoor air supply from 0-100 percent modulating dampers; Provide powered exhaust described below.

U. Discharge Line Thermostat

1. A bi-metal element discharge line thermostat shall be installed on the discharge line of each system. This provides protection to the compressors against high discharge temperatures in case of loss of charge, extremely high ambient and other conditions which could drive the discharge temperature higher. Discharge line thermostat is wired in series with high pressure control. When the discharge temperature rises above the protection limit, the bi-metal disc in the thermostat switches to the off position, opening the 24 VAC circuit. When the temperature on the discharge line cools down, the bi-metal disc closes the contactor circuit, providing power to the compressor. When the thermostat opens the fourth time, the ReliaTel control must be manually reset to resume operation on that stage.

V. Hinged Access Doors

1. Provide sheet metal hinges on the Filter/Evaporator Access Door and the Compressor/Control Access Door.

W. Two-Inch Pleated Filters (Merv 8)

1. Two inch pleated media filters shall be provided.

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X. Powered Exhaust

1. The powered exhaust shall provide exhaust of return air, when using an economizer, to maintain better building pressurization.

Y. Tool-Less Hail Guards

1. Provide tool-less, hail protection quality coil guards for condenser coil protection.

Z. BACnet Communications

1. The BACnet communications interface allows the unit to communicate directly with a generic open protocol BACnet MS/TP Network Building Automation System Controls.

AA. Differential Pressure Switches

1. Provide individual fan failure and dirty filter indication. The fan failure switch shall disable all unit functions and "flash" the Service LED on the zone sensor. The dirty filter switch shall light the Service LED on the zone sensor and shall allow continued unit operation.

2.4 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
- B. Curb Height: 14 inches.

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 RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 INSTALLATION

- A. Roof Curb: Install on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7. Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and discharge on roof.
- B. Install piping adjacent to RTUs to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Division 22. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

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3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions
- C. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 237413

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SECTION 238126.13 – MINI-SPLIT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system heat-pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Related Sections:
 - 1. Section 230713 “Duct Insulation”.
 - 2. Section 230719 “HVAC Piping Insulation”.
 - 3. Section 230900 “Instrumentation and Control for HVAC”.
 - 4. Section 233113 “Metal Ducts”.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 210/240 and bear the ARI Certification label.

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Unit shall be stored and handled according to the manufacturer's recommendations.
- B. The controller shall be shipped separately and shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.7 COORDINATION

- A. Coordinate sizes and locations of roof equipment supports and roof penetrations with actual equipment provided.

1.8 WARRANTY

- A. The units shall have a manufacturer's parts and defects warranty for a period five (5) year from date of installation. The compressor shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide equipment manufactured by Mitsubishi / The Trane Company or a comparable product by:
 1. Daikin.

2.2 OUTDOOR UNIT

- A. The connected indoor unit shall be of the same capacity as the outdoor unit.

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- B. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.
- C. The outdoor unit shall be capable of cooling operation down to ambient temperature of 0°F for heat pump systems without additional low ambient controls (optional wind baffle shall be required).
- D. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) between indoor and outdoor units.
- E. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
- F. Cabinet
 - 1. The casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a Munsell 3Y 7.8/1.1 finish.
 - 2. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability.
 - 3. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
 - 4. The fan grill shall be of ABS plastic.
- G. Fan
 - 1. Models PUZ(Y)-A12/18/24/30NH/KA7 shall be furnished with a single DC fan motor. Model PUZ(Y)-A36/42NH/KA7 shall have two (2) DC fan motors.
 - 2. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.
 - 3. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent external contact with moving parts.
- H. Coil
 - 1. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.
 - 2. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be control by a microprocessor controlled step motor.

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I. Compressor

1. The compressor for models PUZ(Y)-A12/18/24/30/36/42NH/KA7 shall be a DC twin-rotor rotary compressor with Variable Speed Inverter Drive Technology.
2. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings.
3. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
4. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

J. Electrical

1. The electrical power of the unit shall be 208volts or 230 volts, single phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
2. Power for the indoor unit shall be supplied from the outdoor unit via Mitsubishi Electric A-Control using three (3) fourteen (14/16) gauge AWG conductors plus ground wire connecting the units.
3. The outdoor unit shall be controlled by the microprocessor located in the indoor unit.
4. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC.
5. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

- K. Unit shall be able to provide 100% cooling capacity when operating at 0°F outdoor air temperature when a wind baffle is used.

2.3 INDOOR UNIT

A. General:

1. The ceiling-concealed ducted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor.
2. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function.
3. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

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B. Cabinet:

1. The unit shall be ceiling-concealed, ducted—with a horizontal return and a horizontal discharge supply.

C. Fan:

1. Indoor unit shall feature multiple external static pressure settings ranging from 0.14 to 0.60 in. WG.
2. The indoor unit fan shall be an assembly with statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.
3. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function

D. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.
3. Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.
4. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 27 inches above the condensate pan.

E. Electrical:

1. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit, using the Mitsubishi Electric A-Control system.
2. For A-Control, a three (3) conductor AWG-14/16 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.

2.4 REFRIGERANT TUBING

- A. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ACR Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1” thick insulation shall have

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a - Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.

2.5 SYSTEM CONTROL

- A. The control system shall consist of a minimum of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.
- B. A three (3) conductor 14 gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. A 3-Pole disconnect is required for the indoor unit.
- C. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
- D. Each system shall have a wired, wall mount, remote controller.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on roof equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

3.2 CONNECTIONS

- A. Install and connect refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- B. Connect condensate drain piping to indoor unit.

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- C. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- D. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- I. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- J. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- K. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves for HVAC Piping."
- M. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

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3.4 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 72 inches; minimum rod, 3/8 inch.
 - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
 - 8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
 - 9. NPS 4: Maximum span, 10 feet; minimum rod, 1/2 inch.
- C. Support vertical runs at maximum spacing of 10 feet.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

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3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126.13

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SECTION 238239 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Chromalox, Inc.
 - 2. Indeco.
 - 3. Markel Products Company; TPI Corporation.
 - 4. QMark; Marley Engineered Products.

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2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- 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. Refer to equipment schedule for types, capacities, controls and options.

2.3 CABINET

- A. Front Panel: Stamped-steel louver or extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color.

2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection.

2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

- A. Controls: Unit-mounted thermostat unless indicated otherwise.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with manufacturer's instructions and NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 238239

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SECTION 260100 - BASIC REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the basic requirements of electrical installations and includes requirements common to all sections of Divisions 26, 27 and 28. It expands and supplements the requirements specified in sections of Division 1.
- B. Division 26 shall provide the electrical equipment, electrical wire, raceways and cable work and connections as required for complete and operable electrical systems as indicated in Division 26 Contract Documents. Refer to all other portions of these Contract Documents and apply to those portions of work relating to Electrical Work the same as if the Electrical Work was repeated herein in its entirety.
- C. Other Divisions of these Contract Documents will provide equipment that will require electrical connections - Division 26 shall coordinate with other Divisions and shall provide all necessary items and equipment for complete and code-compliant connections.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 SCOPE OF THE WORK

- A. Work included under this section shall include complete electrical systems as shown on the Contract Documents, which includes all of the specifications, drawings, addendums, accepted change orders and the Authority Having Jurisdiction (AHJ) compliances. Provide supervision, labor, material, equipment, machinery, plant, and other items necessary to complete the systems. Items of equipment may be specified in the singular; however, provide the number of items of equipment indicated in the Contract Documents and as required for complete systems.
- B. It is the intention of these Contract Documents to call for finished work, tested and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."
- C. Minor details necessary for the complete installation and operation of the systems shall be included.
- D. Any item that is shown on the drawings but not mentioned in the specifications, or mentioned in the specifications but not shown on the drawings, shall be considered as being both shown on the drawings and mentioned in the specifications and shall be provided.

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- E. The entire work provided for in the specifications and indicated on the drawings is to be accomplished even though every item and minor detail for the proper installation and successful operation of the entire work may not be mentioned in the specifications or shown on the drawings.
- F. All materials and equipment shall be new and listed by Underwriters Laboratories, Inc.

1.4 PERMITS AND FEE

- A. The Contractor shall obtain and pay for all permits, bonds, licenses, and inspection certificates, and shall pay inspection fees and taxes, but permanent electrical utility fees shall be paid by the Owner.
- B. The Contractor shall file plans and prepare documents required to obtain approvals of the Authorities Having Jurisdiction (AHJ).

1.5 DRAWINGS

- A. Electrical drawings are diagrammatic and indicate general arrangement of systems and work included. Consult Architectural and Structural drawings for building construction details.
- B. Should there be any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, notify the Architect/Engineer and make modifications as directed.
- C. Where variances occur between drawings and specifications or within either document itself, include in the contract price the item or arrangement of better quality, greater quantity, or higher cost.

1.6 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to equipment specifications in Divisions 2 through 23 for rough-in requirements.
- B. Rough-in openings shall align vertically and horizontally with the building structure and shall be plumb.
- C. Verify door swings before roughing-in switch outlets.

1.7 ELECTRICAL INSTALLATIONS

- A. In addition to the requirements of the General Conditions, examine areas and conditions for compliance with installation tolerances and other conditions affecting performance of electrical work. Do not proceed with installation until unsatisfactory conditions have been corrected. Verify all dimensions by field measurements.

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- B. Install material and equipment in accordance with manufacturer's written installation instructions, applicable requirements of the National Electrical Contractors Association (NECA) "Standard of Installation" and applicable requirements of National Electrical Code (NEC).
- C. Coordinate electrical equipment and materials installation with other building components.
- D. Arrange for chases, slots and openings in other building components to allow for electrical installations.
- E. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
- F. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building. Where housekeeping pads are required, they shall be minimum 4" tall and shall meet Division 3 specifications.
- G. Where mounting heights are not indicated, detailed or dimensioned, bring to the attention of the Architect immediately for resolution.
- H. Install electrical equipment with National Electrical Code (NEC) required clearances to facilitate maintenance and repair or replacement of equipment components. Connect equipment in such a way as to facilitate future maintenance, with minimum of interference with other items in the vicinity. Do not run any conduits across any designated rooftop walkways – if this is unavoidable, provide a removable platform or stairs to safely walk over the conduits.
- I. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components. Do not block mechanical equipment access with raceways.
- J. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
- K. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.
- L. All wiring connectors and terminals (including but not limited to wiring devices, breakers, disconnects, fuses, starters, etc.) shall be rated for not less than 75 deg. C. If connectors and terminals are provided that are rated for less than 75 deg. C., the electrical contractor shall incur all costs associated with upsizing conductors and conduits as required by the NEC for lower-temperature conductors.
- M. All damages incurred to new or existing electrical installations shall be immediately reported to the general contractor project manager and repaired by the contractor at no cost to Owner.

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- N. Site-Applied Interior Paints and Coatings: Comply with low-emitting requirements in Division 01 Section "Indoor Air Quality Requirements."

1.8 PROTECTION

- A. Protect work against theft, injury, or damage. Carefully store material and equipment off the ground and under cover. Close open ends of work or equipment with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.9 EXCAVATION AND BACKFILLING

- A. Excavate to the depths required for the installation of electrical work. The Contractor shall be responsible for obtaining core drill sample information prior to receipt of bids to determine presence or absence of rock. After receipt of bids, no extras will be allowed for excavation of rock. Remove and properly dispose of excavated materials not required or suitable for backfill. Provide shoring as necessary to protect existing facilities, new work, and the safety of personnel. Make open cut excavation, except for short sections of trench which may be tunneled if conduit or duct can be properly installed and supported.
- B. Grade the bottom of trenches to provide uniform bearing and support for each section of conduit on undisturbed soil at every point along its entire length. Backfill trench over depths with sand, fine gravel, or loose, granular, moist earth and thoroughly tamp. Unstable soil that is incapable of properly supporting conduit shall be removed to stable soil and the trench treated as over depth.
- C. Existing utility lines to be retained, whether known or unknown, and uncovered during excavation operations shall be protected from damage during excavation and backfilling, and if damaged shall be restored to original condition.
- D. Do not backfill until all tests have been performed and the utility systems installed conform to the requirements of the Contract Documents. Carefully backfill trenches with clean earth, sand, and gravel or soft shale in 6-inch layers and thoroughly tamp until the conduit has a cover of not less than 2 feet. Place the remainder of the backfill in the trench in 1-foot layers and tamp. Grade surface to reasonable uniformity and mound over trenches. Use compacted backfill for excavation under slabs on grade, building structures, concrete or asphalt paving, and driveway or parking areas.
- E. Check elevations of utilities entering and leaving building. When such elevations require excavations lower than footing levels, notify Architect and proceed as directed by him. Make excavations at minimum required depths in order not to undercut footings.

1.10 ACCESSIBILITY

- A. Furnish, for installation by others, access doors in every location necessary and as required by Code or equipment manufacturer recommendation, whether indicated or not, to allow working access to concealed electrical items which may require operation, inspection, maintenance, or

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adjustment. Access doors are not required in lay-in panel systems. See Division 8 for specification and installation requirements.

- B. Coordinate the final location of concealed equipment and devices requiring access with final location of access doors. Access unit shall be of adequate size and shall match the wall, floor and ceiling rating and construction type. Allow ample space for removal of all parts that will likely require replacement or servicing during the normal life of equipment.
- C. Prior to installation of equipment and materials requiring access doors, prepare, for review by the architect in ample time for proper coordination, one (1) set of architectural prints marked with size and approximate location of all access doors.

1.11 SEALANTS

- A. See Division 7 for fire-stopping sealants required around conduit and/or cable penetrations through fire-rated assemblies. Also, see Division 7 joint sealants required around conduit and/or cable penetrations through joints. See Division 7 for weatherproof sealants required around conduit and/or cable penetrations through water tight assemblies such as exterior walls and roof.
- B. Apply sealant around all exterior mounted electrical devices to provide weatherproofing and pest control.

1.12 CUTTING AND PATCHING

- A. This Article supplements sections of Division 1 for general requirements for cutting and patching and specifies the cutting and patching for electrical equipment, components and materials, to include removal and legal disposal of selected materials, components, and equipment.
- B. Do not endanger or damage installed work through procedures and processes of cutting and patching.
- C. Arrange for repairs required to restore other work because of damage caused as a result of electrical installations.
- D. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.
- E. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - 1. Uncover work to provide for installation of ill-timed work;
 - 2. Remove and replace defective work;
 - 3. Remove and replace work not conforming to requirements of the Contract Documents;
 - 4. Remove samples of installed work as specified for testing;
 - 5. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect/Engineer observation of concealed work.

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1.13 SLEEVES

- A. Locate sleeves during normal course of work. Provide sleeves for conduit larger than 1" passing through concrete floor slabs and concrete, masonry, tile, and gypsum wall construction. Sleeves shall not be provided for conduit running embedded in concrete or slab on grade. Sleeves through structural members shall be only as directed by Architect.
- B. All conduits passing through fire-rated walls or floors or ceilings shall have sleeve assemblies to maintain the fire rating of the wall or floor or ceiling. Pack between sleeve and conduit with U.L. Listed material to maintain wall or floor or ceiling rating. See Architectural drawings for locations of fire-rated walls, floors and ceilings.
- C. Sleeves shall be constructed of 20 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated.
- D. Fasten sleeves securely in floors or walls so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials from being forced into the space between pipe and sleeve during construction.

1.14 MOTOR AND ELECTRICAL WIRING

- A. Temperature control wiring, equipment control wiring, and interlock wiring necessary for the proper sequence of operation of mechanical equipment will be provided as part of the Mechanical Work. See Division 23 for instrumentation and control for HVAC, and for the complete definition of control wiring.
- B. Power wiring from the power source to the motor or equipment junction box, including wiring through starters, VFD's and safety switches shall be provided as part of the Electrical Work under Division 26.
- C. Power wiring from the power source to electric heating equipment, including wiring through contactors, safety switches and line voltage control devices shall be provided as part of the Electrical Work under Division 26.

1.15 QUALITY ASSURANCE

- A. Manufacturers: Where a list of manufacturers or a proprietary item is not specified, use manufacturers whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Firms with at least three (3) years of successful installation experience on projects utilizing material similar to that required for this project.
- C. Codes and Standards: Comply with applicable requirements of the following codes and standards.

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1. National Electrical Manufacturers Association (NEMA) Standards.
2. 2014 NFPA 70 - National Electrical Code (NEC)
3. 2013 NFPA 72 – National Fire Alarm and Signaling Code
4. 2015 VUSBC – Virginia Uniform Statewide Building Code (VCC – Virginia Construction Code)
5. 2015 IBC - International Building Code as adopted and modified by the VUSBC (VCC)
6. 2015 IFC – International Fire Code
7. 2015 VECC – Virginia Energy Conservation Code
8. 2010 Americans with Disabilities Act Accessibility Guidelines (ADAAG)
9. 2010 ADA Standards for Accessible Design
10. Institute of Electrical and Electronics Engineers (IEEE) Standards
11. National Electrical Safety Code (NESC)
12. Other applicable ANSI/NFPA & UL Standards as required for the project

- D. Provide material and equipment which is listed by Underwriters Laboratories, Inc. (UL) and which bears the UL label. This applies to materials and equipment for which UL Standards have been established and for which label service is regularly furnished. Assemble materials and equipment, for which no UL Product Category exists for the completed unit, with UL-listed components.

1.16 ELECTRICAL SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 for submittal definitions, requirements and procedures.
- B. Submittal of shop drawings, product data and samples will be accepted only when submitted by the General Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.
- C. Submittals that are not acceptable must be resubmitted until returned as approved by the engineer. If the third submittal is not approved, the contractor will be responsible for paying additional fees for subsequent reviews of submittals at a rate of \$200 per hour, and the specified item may be required to be provided at the engineer's discretion at no additional cost to the contract. Submittals will not be returned until payment is received.

1.17 BIDDING INSTRUCTIONS

- A. Products are generally specified by a performance specification and/or by manufacturer's name and model number or trade name.
1. When specified only by a performance specification, the Contractor may use any manufacturer who meets the performance specification and applicable codes.
 2. When several products/manufacturers are specified together, then the Contractor has the option of using any product/manufacturer listed. The Contractor shall be subject to the requirements of paragraph 1.16 - ELECTRICAL SUBMITTALS. The Contractor's bid shall be compiled on the use of the listed products without exception. Substitutions will

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only be considered after the contract has been signed and shall be subject to the requirements of paragraph 1.18 - SUBSTITUTIONS.

3. When several products/manufacturers are specified together and the system design is based on one of the listed products by specific model number(s) or catalog number(s), the Contractor has the option of using the one specific product or any product/manufacture listed. However, when another listed product/manufacture is used, the Contractor shall be responsible for determining that the product(s) are compatible with building design, electrical design, and mechanical design; are equal to the basis-of-design product in quality, appearance, construction and performance (including lamping and lenses for lighting fixtures); and will not necessitate design modifications by the Architect/Engineer. The Contractor's bid shall be compiled on the use of the listed products/manufactures without exception. Substitutions will only be considered after the Contract has been signed and shall be subject to the requirements of paragraph 1.18 - SUBSTITUTIONS.
4. When only one manufacturer's name is listed with the catalog number, this shall be the basis of the bid. The Contractor's bid shall be compiled on the use of the listed product(s) only. Substitutions will only be considered after the Contract has been signed and shall be subject to the requirements of paragraph 1.18 - SUBSTITUTIONS.
5. A request for substitution shall be made in writing from the General Contractor only. Requests by distributors, manufacturers, or manufacturer's representatives will not be considered. Oral requests will not be considered. Request for deviations from product specifications will not be considered.
6. Request for substitutions will not be considered during bidding unless the specified product is discontinued.
7. If approval for a substitution is granted, samples shall be submitted if and as requested by Engineer.
8. Approval of substitutions prior to shop drawing submittal will not be granted.

1.18 SUBSTITUTIONS

- A. Where a specified lighting fixture is a standard cataloged product of a manufacturer, custom-made fixtures by another manufacturer will be considered. The engineer reserves the right to require a photometric test and IES file and/or an operating sample (at no additional cost to the contract) before approving or rejecting a custom substitute. IES files shall be the result of independent third-party testing of the actual fixture, not projections of how the fixture is expected to perform.
- B. Substitutions are understood to mean that the Contractor:
 1. Has personally investigated the proposed substitute and has determined that it is equal or superior in all respects, including appearance, to the item specified;
 2. Will provide the same guarantee for the substitution that he would for the equipment specified;
 3. Has coordinated the installation of the substitute, providing design modifications and changes as required for the work to be complete in all respects;
 4. Has coordinated the installation of the substitute with the General Contractor pertaining to changes required for the work to be complete with all trades (all changes shall be provided without additional cost to the contract);
 5. Has provided the amount of credit due the Owner if the substitution is accepted.

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6. All required design modifications and/or changes shall be submitted with the shop drawings for the substitute equipment.
- C. The Architect/Engineer will indicate on which of these items the Contractor may submit shop drawings for review. The acceptance by the Architect/Engineer of any or all of those items listed by the Contractor for review shall not constitute an approval of the substitute but shall mean that the Contractor may then submit detailed shop drawings for review. When a request for substitution is granted, the Architect/Engineer will review shop drawings as follows:
1. If shop drawings for the substitute equipment are marked "AMEND & RESUBMIT" on first submittal, the Contractor is allowed to resubmit for two additional reviews, unless the Architect/Engineer provides other instructions. If after the third review, the substitute equipment is not accepted, the specified equipment shall be provided without any additional cost to the contract.
 2. If shop drawings for the substitute equipment are marked "REJECTED – SEE REMARKS" at any submittal level, the Contractor shall stop any further submittals of any substitute equipment. The Architect/Engineer will not review any additional substitute equipment and the Contractor shall submit and provide the specified equipment without any additional cost to the contract.

1.19 SIMILAR PRODUCTS

- A. When two or more items of same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, conductors, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners and similar items used in Work, except as otherwise indicated.
- B. Provide products which are compatible within systems and other connected items.

1.20 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power-operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Provide the manufacturer's nearest authorized servicing agency, address and emergency telephone number.

1.21 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications. Products shall be adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

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- C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.22 IDENTIFICATION

- A. Coordinate all room number designations with the final room numbers. Use final room numbers for all final documentation and display, including but not limited to, programming, alarm displays, annunciator displays, panelboard schedules, signage, labels, and engraved labels. The room numbers shall be as directed by the Owner and may not be the same as shown on Contract Drawings. Include final room numbers on the drawings for the Record Documents.

1.23 RECORD DOCUMENTS

- A. Refer to the sections of Division 1 for record document requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark Drawings to indicate revisions to lighting fixture and wiring device layout; conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned from column lines; distribution and branch electrical circuitry; fuse and circuit breaker sizes and arrangements; support and hanger details; concealed control system devices; panel schedules.
- C. Mark Contract Documents to indicate accepted substitutions, Change Orders and actual equipment and material used on the project.
- D. Within 30 days after the date of system acceptance, as-built record drawings of the following shall be provided to the Owner in accordance with energy codes
 - 1. Single-line diagram of the building electrical distribution system
 - 2. Floor plans indicating the location and area served for all electrical distribution equipment.
- E. Within 90 days after the date of system acceptance, as-built record drawings of the actual lighting and associated controls installations shall be provided to the Owner, including the location, luminaire identifier, and control & circuiting for each piece of lighting equipment, in accordance with energy codes

1.24 OPERATING AND MAINTENANCE DATA

- A. Refer to the sections of Division 1 for procedures and requirements for preparation and submittal of maintenance manuals.
- B. In addition to the information required by Division 1 for Maintenance Data, include the following information:

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1. Submittal data stating equipment rating and selected options for each piece of equipment requiring maintenance. Include description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
 3. Operations and maintenance manuals for each piece of equipment requiring maintenance. Include maintenance procedures for routine preventative maintenance and troubleshooting, disassembly, repair and reassembly, aligning and adjusting instructions. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label; the label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.
 4. Servicing instructions and lubrication charts and schedules.
 5. Names and addresses of at least one qualified service agency for each piece of equipment or system.
 6. A complete narrative of how each system is intended to operate.
- C. For compliance with energy codes, provide a lighting equipment and controls operations and maintenance manual to the Owner within 90 days after the date of system acceptance. These manuals shall include the following:
1. Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.
 2. Operation and maintenance manuals for each piece of lighting equipment and lighting controls with routine maintenance clearly identified, including a recommended re-lamping program and a schedule for inspecting and recalibrating all lighting controls.
 3. A complete narrative of how each lighting control system is intended to operate, including recommended settings.
- D. Compile and assemble the manuals for Divisions 26, 27 and 28 into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference. Only one copy of each manual needs to be submitted for engineer review.
- E. For the Owner's use, provide 2 copies of all O&M manuals, diagnostic tools, software and sufficient training for all electrical systems and their components (fire alarm, lighting controls, digital meters, etc.).
- 1.25 WARRANTIES
- A. Refer to the sections of Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
 - B. Compile and assemble the warranties for Divisions 26, 27 and 28 into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
 - C. Provide complete warranty information for each product or piece of equipment, including date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and

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telephone numbers and procedures for filing a claim and obtaining warranty services. Only one copy of each warranty needs to be submitted for engineer review.

1.26 CLEANING

- A. Refer to the sections of Division 1 for general requirements for cleaning.
- B. Clean all panelboards, lighting fixtures, and lenses prior to final acceptance. Replace all inoperative LED boards and LED drivers.

1.27 SITE VISIT REPORTS

- A. Respond in writing to each item of discrepancy noted on all site visit reports.

END OF SECTION

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of the low voltage power and lighting wiring. Extent of electrical wire and cable shall be as indicated and required for complete and operable electrical systems.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.
- B. Refer to other Division 7, Division 26 and Division 31 sections for requirements for penetration firestopping, requirements for electrical installations, grounding and bonding, raceway and boxes and earthwork.

1.3 REFERENCES AND CODES

- A. NEMA WC 70 Standard for Non-shielded Power Cable 2000 volts or Less for the Distribution of Electrical Energy (2009).
- B. 2014 NFPA 70 National Electrical Code

1.4 SUBMITTALS

- A. In accordance with sections of Division 1, furnish the manufacturer's literature and data showing each conductor and cable type and rating.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to Authorities Having Jurisdiction.

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- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with applicable requirements of NFPA 70 (NEC) pertaining to the construction and installation of electrical wires and cables.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver wire and cable properly packaged in factory fabricated containers or wound on NEMA-specified wire and cable reels. Each coil or reel shall contain only one continuous cable without splices.
- B. Handle wire and cable carefully to avoid abrading, puncturing or tearing wire and cable insulation and sheathing. Ensure the dielectric resistance integrity of the wire and cable is maintained.
- C. Store wire and cable in a clean, dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. General: Provide electrical conductors and cables of manufacturer's standard materials, as indicated by published product information, designed and constructed as recommended by manufacturer for a complete installation and for applications indicated.
- B. Line Voltage (100 to 600 volts): Provide copper conductors with conductivity of not less than 98% at 20 degrees C (68 degrees F). All indicated conductor sizes in construction documents are based on copper. Provide color-coding of conductors. Use factory applied colored insulation for conductors #6 AWG and smaller. Use colored self-adhesive vinyl tape for #4 AWG and larger at terminations and splices. For 208Y/120 volt or 120/240 volt delta systems, provide black for phase A, red for phase B, blue for phase C, and white for neutral. Provide ground conductor color as required by the NEC.
 - 1. Provide factory-fabricated copper conductors of sizes, ampacity ratings, and materials for applications and services indicated. Provide conductors with Type XHHW or XHHW-2 or THHN or THWN-2 insulation with a minimum rating of 90 degrees C, which are the indicated conductors scheduled.

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2. Provide solid conductors for sizes #10 AWG and smaller. Provide stranded conductors for sizes #8 AWG and larger. Provide minimum conductor size of #12 AWG, larger where indicated.
3. For 120-volt 15 amp and 20 amp branch circuits, use minimum 12 AWG up to 60 feet, 10 AWG for 61-95 feet, 8 AWG for 96-155 feet and 6 AWG for branch circuits longer than 155 feet. Conductors shall be same size for entire length of run, except if all outlets are in the same room (1200 square feet or less) the oversized conductors may be run only to the first outlet.
4. For 277-volt 15 amp and 20 amp branch circuits, use minimum 12 AWG up to 140 feet, 10 AWG for 141-220 feet and 8 AWG for branch circuits longer than 220 feet. Conductors shall be same size for entire length of run.
5. Cables: Provide UL-type factory-fabricated cables of materials and jacketing/sheathing as indicated below for services indicated. Re-size cable conductors based on equal to or greater equivalent 75 degree C rated copper conductors as scheduled if cables are used. Select cables with construction features which fulfill project requirements. At Contractor's option, the following cable types are acceptable where indicated:
 - a. Type "AC"--ARMORED CABLE
 - b. Type "MC"--METAL-CLAD CABLE
 - c. Types "SE" & "USE"--SERVICE AND UNDERGROUND SERVICE
 - d. Type "UF"--UNDERGROUND FEEDERS AND BRANCH CIRCUITS
 - e. Type "SO"--CORD
6. Fire Alarm Circuits: Type THHN/THWN or THHN/THWN-2 in full metal raceway system where installed in concealed walls and ceilings or outdoors (above or below grade) in combination with power-limited signaling circuit cables where allowed by code. Where required provide plenum rated or fire-protective signaling circuit cables/assemblies in accordance with the instructions by the manufacturer.

2.2 CONNECTORS

- A. General: Provide proper current-carrying material suitable for conductors used.
- B. Line Voltage (100 to 600 volts):
 1. Splices: Provide solderless, screw-on, reusable pressure cable type, 600 volt connectors for conductors #10 AWG and smaller constructed of corrosion-resistant steel or copper spring and a vinyl or plastic insulator which is temperature-rated 105 degree C and approved for copper conductors. Provide compression connectors for conductors #8 AWG and larger constructed of copper, copper alloy or aluminum.
 2. Terminations: Provide compression-type terminations rated 600V and 105 degree C, constructed of tin-plated copper; serrated barrel; chamfered conductor entry.

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All compression terminations shall be applied using the manufacturer's recommended compression tool for the size of termination used. The terminations shall be of exact size to fit the conductors and shall be installed to bring uniform pressure on all sides of the joint and assure a permanent high-conductivity connection. Where terminations are supplied as standard material on equipment, contractor may elect to utilize such termination in lieu of those specified herein.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS, CABLES AND CONNECTORS

- A. Coordinate conductors/cable installation work, including electrical raceway and equipment installation work, as necessary to properly interface installation of conductors/cables with other work.
- B. Unless otherwise indicated, install individual conductors in raceways.
- C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- D. Support cables according to NEC and cable manufacturer's instructions.
- E. Cables penetrating fire-rated elements shall be sealed according to Division 7.
- F. Type AC, MC, SE, USE, SO and UF cable may be used in areas where permitted by NEC and local codes, but only for branch circuits above accessible ceilings and in stud walls. Only cables with 75 degree C rated insulation are permitted. Where running into a panel where the ceiling space is inaccessible, conduit shall be run from the panel to a junction box above the nearest accessible ceiling. Cables shall be run neatly in straight parallel runs with proper support and limited sag.
- G. Provide cables in plenum spaces in metallic raceways or with cable jackets approved for use in plenum spaces.
- H. Pull conductors simultaneously where more than one is being installed in same raceway.
- I. 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.

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- J. Use pulling means, including fish tape, cable, rope and basket weave conductor/cable grips, which will not damage cables or raceway. Remove and replace all conductors/cables with damaged jacket or insulation.
- K. Install splices at accessible outlet or junction boxes. Keep splices in underground junction boxes, hand holes, and manholes to an absolute minimum. Where splices are necessary, arrange to minimize the effects of moisture.
- L. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.
- M. Where ground conductors are required to be run in same raceway as phase conductors, the ground conductor shall be run continuous throughout each circuit and the ground conductor pigtailed to the device to ensure ground continuity.
- N. Do not install a shared neutral on any circuit. Install capped neutral conductors in switch boxes where required by NEC 404.2(C).
- O. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- P. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.

3.2 INSTALLATION OF CONDUCTORS AND CABLES FOR POWER LIMITED CIRCUITS

- A. Wiring for signaling and power limited circuits may be run exposed in the following locations:
 - 1. Above accessible ceilings where not exposed to view.
- B. Provide signaling and wiring for power limited circuits in raceways in the following locations:
 - 1. In all locations not specifically listed above.
 - 2. Where concealed in inaccessible locations.
 - 3. In elevator equipment rooms and hoistways.
- C. Install exposed conductors or cable parallel and perpendicular to building surfaces, or exposed structural members, and follow surface contours where possible.
- D. Install conductors and cables in a neat and workmanlike manner.

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- E. Support conductors and cables frequently to prevent excessive sag. Support a minimum of 6" above suspended ceilings. Do not support conductors or cables from conduit or other raceway.
- F. Parallel cable runs shall be installed adjacent to each other. Tie adjacent runs in neat bundles.
- G. Install conductors and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals.
- H. Provide conductors and cables in accordance with requirements of manufacturer.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of circuitry, check low voltage installed conductors and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, test low voltage conductors and cables for electrical continuity, short circuits and grounds. Also, test conductor phase-to-phase and phase-to-ground.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies general grounding and bonding requirements of electrical equipment operations for safety and to provide a low impedance path for possible ground fault currents. Extent of grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits and equipment.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to other Division 26 sections for conductors/cables, electrical raceways, boxes and fittings which are required in conjunction with electrical grounding and bonding work.

1.4 REFERENCES AND CODES

- A. Electrical Code Compliances: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to electrical grounding and bonding, pertaining to systems, circuits, and equipment. Particular attention is called to Article 250.
- B. U.L. Compliance: Comply with applicable requirements of UL Standards Nos. 467, "Electrical Grounding and Bonding Equipment", and 869, "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are U.L. Listed and labeled for their intended usage.
- C. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

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1.5 SUBMITTALS

- A. Submit manufacturer's data on grounding and bonding products and associated accessories.

PART 2 - PRODUCTS

2.1 GROUNDING SYSTEMS

- A. General: Except as otherwise indicated, provide electrical grounding and bonding systems in accordance with the NEC, with assembly of materials including, but not limited to: conductors/cables, connectors, terminals (solderless lugs), compression connectors, mechanical connectors and/or exothermic process connections, grounding electrodes and bonding jumpers, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Contractor's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE and established industry standards for applications indicated.
- B. Conductors: Unless otherwise indicated, provide electrical grounding conductors matching power supply wiring materials and sized according to NEC.

2.2 MISCELLANEOUS MATERIAL

- A. Bonding Jumper Braid: Copper braided tape constructed of 30 gauge bare copper wires and properly sized for indicated applications.
- B. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals and clamps for indicated applications.
- C. Ground Busbar: Provide ground busbar of 1/4" thick, tin-plated copper; 15 1/2"L x 4"W; tower mounting with nylon polyamide insulators and stainless steel brackets and bolts for a total stand-off height of 2"; predrilled with 19 pairs of 5/16" holes and 3 pairs of 7/16" holes.
- D. Grounding Electrodes (Rods): Steel with copper welded exterior, 3/4 inch diameter and 10 feet length.

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- E. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials and bonding jumpers, as recommended by accessories manufacturers for type services indicated.
- F. Compression Connectors: Compression connectors shall be manufactured from pure, wrought copper in compliance with ASTM B187.
- G. Mechanical Connectors: Mechanical cast connectors shall be manufactured from a copper alloy of minimum 80% copper, according to ASTM B30.
- H. Field Welding: Comply with AWS Code for procedures, appearance, quality of welds and methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground grounding electrodes. Welds shall utilize the exothermic process.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until satisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. General: Install electrical grounding and bonding systems required in accordance with manufacturer's instructions and applicable portions of the NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.
- B. Provide insulated equipment grounding conductors in the same raceway with phase conductors for all feeders (panelboards, control centers and distribution transformers), motor circuits, branch circuits and site lighting. Ground conductors shall be continuous from the equipment to the ground bus of the switchboard, panelboard or control center serving the equipment.
- C. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system with other work.
- D. Drive each grounding electrode (ground rod) vertically in the soil such that a minimum 8'-0" of length is in contact with the soil with the upper end of the electrode a minimum

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2'-0" below finished grade level, but below the permanent moisture level. Utilize an exothermic welding process to connect grounding conductors to the underground grounding electrodes and at other inaccessible or concealed locations.

- E. Install standard cable bonding jumpers with ground clamps on water piping to electrically bypass water meters, water heaters, insulated joints and any equipment which is likely to be disconnected for repairs or replacement, refer to NEC 250.53 (D) (1).
- F. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- G. Ground electrical service system neutral at service entrance equipment to grounding electrodes. Make ground connections in accordance with NEC and local utility company requirements. Bonding jumpers at the service shall comply with NEC 250.92.
- H. Ground each separately-derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member or separate grounding electrode.
- I. Connect together system neutral, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, wiring device ground connectors and plumbing systems. Particular attention is called to NEC 250.92, 250.97 and 250.98 for metal raceway bonding requirements. Ground cord-and-plug connected equipment in accordance with NEC 250.114.
- J. Provide a ground bar in each communication room and electric room where indicated. Ground bars shall be mounted with long dimension horizontal and with bottom of bar 12" above the finished floor. Ground each bar as noted on drawings.
- K. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug to ground bar or bus.
- L. Connect grounding electrode conductors to metallic cold water pipe and sprinkler main within 5 feet of the entrance point into the building using a suitably sized ground clamp, refer to NEC 250.68 (C) (1). Also bond gas piping, metallic water piping and metal structural members to system ground where applicable in compliance with NEC 250.104.
- M. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.
- N. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

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- O. All ground connectors shall be designed for fault-duty loading and shall have the fault capacity of the maximum sized conductor for which it is designed.
- P. Bolt hole connectors and in-line splices shall accommodate only one conductor size. All other ground connectors shall be range taking.
- Q. Structural steel and busbar ground connectors shall accommodate only one rigid member conductor.
- R. All ground connectors shall be provided with a corrosion-inhibiting compound preapplied to the contact surfaces. The compound shall be compatible with the conductors accommodated by the connector.
- S. All ground connectors shall be capable of being provided with tin plating, if required by the application.
- T. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- U. Compression and Mechanical Connector Marking:
 - 1. All connectors shall be clearly and permanently marked with the following information:
 - a. Manufacturer's inspection symbol
 - b. Catalog number
 - c. Conductor accommodation(s)
 - d. Installation die index or die catalog number (compression)
 - e. Underwriters Laboratories Listing Mark
 - f. The words "Suitable for Direct Burial," or "Direct Burial," or "Burial" as specified per ANSI/UL467.
 - 2. The smallest unit package shall contain the information listed under U.1 and shall also include installation tooling.
- V. Ground Connector Installation Using Compression and Mechanical Connectors:
 - 1. Installation of connectors shall be made in accordance with the manufacturer's recommendations. The instructions typically include conductor preparation (cleaning, pre-crimp), installation tool and die selection, and application of the proper number of crimps.

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2. Connectors shall be installable under all types of weather/field conditions without special safety precautions or procedures.
3. Connectors shall be installable without using or producing hazardous materials or by-products.

3.3 FIELD QUALITY CONTROL

A. Ground Connector Inspection:

1. Compression dies shall provide embossment of the connector upon successful installation. The embossed index shall match the marking on the installed connector.
2. Connector marking information specified above shall be legible after installation for inspector cross-reference.
3. Closed barrel connectors shall have inspection holes at the appropriate location to verify proper cable insertion.

B. Performance: All system connectors shall be Listed by Underwriters Laboratories for direct burial in earth or embedment in concrete per ANSI/UL467 Standard for Grounding and Bonding Equipment.

C. Upon completion of installation of electrical grounding and bonding systems, test ground resistance of rod, pipe or plate electrodes with ground resistance tester. Where tests show resistance to ground is over 25 ohms, provide additional electrodes as listed by the NEC to reduce resistance to 25 ohms or less. Retest to demonstrate compliance. This test does not apply to supplementary grounding electrodes such as a ground rod provided for exterior lighting fixture poles.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the extent of supports, anchors, sleeves and seals for electrical equipment installations as indicated by drawings and schedules, as specified in the Division 26 sections and as required by the NEC.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES

- A. Electrical Code Compliances: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to construction and installation of electrical supporting devices.
- B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
- C. U.L. Compliance: Provide electrical components which are U.L. Listed and U.L. Labeled.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment system supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear and pullout force to resist maximum loads calculated or imposed under this Project, with a structural safety factor of five times the applied force.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SUPPORT, ANCHORAGE AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers:
 - a. Cooper B-Line; a division of Cooper Industries.
 - b. ERICO International Corporation.
 - c. Allied Support Systems; Power-Strut Unit.
 - d. GS Metals Corp.
 - e. Michigan Hanger Co., Inc.; O-Strut Div.
 - f. National Pipe Hanger Corp.
 - g. Thomas & Betts Corporation.
 - h. Unistrut; Tyco International, Ltd.
 - i. Wesanco, Inc.
 - j. Bridgeport Fittings, Inc.
 - 2. Finishes:
 - a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 3. Channel Dimensions: Selected for applicable load criteria.

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- 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 types and sizes of raceway or cable to be supported.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes and bars; black and galvanized.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Mounting, Anchoring and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers:
 - (1) Hilti, Inc.
 - (2) ITW Construction Products.
 - (3) MKT Fastening, LLC.
 - (4) Simpson Strong-Tie Co. Inc.
 - 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:
 - (1) Cooper B-Line; a division of Cooper Industries.
 - (2) Empire Tool and Manufacturing Co., Inc.
 - (3) Hilti, Inc.
 - (4) ITW Construction Products.
 - (5) MKT Fastening, LLC.
 - (6) Powers Fasteners.
 - 3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

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5. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 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 5 for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch (38 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

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- 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 (90 kg).
- 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 required by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps or Spring-tension clamps.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 for site-fabricated metal supports.
- B. Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 INSTALLATION OF SUPPORTING DEVICES

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- A. Install hangers, anchors, sleeves and seals as required, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps, and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.

END OF SECTION 260529

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SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of conduit, fittings and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise. Extent of raceway work is indicated by drawings and schedules and as required by the NEC.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.
- B. Refer to other Division 7 and Division 26 sections for requirements for penetration firestopping, requirements for electrical installations, grounding and bonding and wiring devices and miscellaneous equipment.

1.3 REFERENCES AND CODES

- A. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication pertaining to raceways.
- B. U.L. Compliance and Labeling: Comply with applicable requirements of U.L. Safety Standards pertaining to electrical raceway systems. Provide raceway products and components which have been U.L. Listed and labeled.
- C. Electrical Code Compliance: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to the construction and installation of raceway systems.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical boxes and fittings, raceways, and thru-wall/floor firestop devices.

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PART 2 - PRODUCTS

2.1 ALL RACEWAYS

- A. General: Provide complete assembly of all raceways, including but not limited to fittings, couplings, conduit bodies, underground raceway seals, service heads, expansion fittings, straps, hangers and other components and accessories as required to complete raceway system.

2.2 METAL RACEWAYS

- A. Rigid Aluminum Conduit: Rigid aluminum 6063 Alloy, T41 temper, conforming to ANSI C80.5. Provide factory-applied, closed-end thread protectors.
- B. Rigid Steel Conduit: Rigid steel, zinc-coated, threaded type conforming to ANSI C80.1. Provide zinc coating fused to inside and outside walls.
- C. Intermediate Metal Conduit (IMC): Rigid intermediate grade steel, hot-dip galvanized conforming to ANSI C80.6.
- D. Electrical Metallic Tubing (EMT): ANSI C80.3. The Contractor has the option of using aluminum EMT where sizes 2" through 4" are required, except where UL firestop assemblies require steel.
- E. PVC Externally Coated Rigid Steel Conduit: Rigid steel zinc-coated with additional external coating of PVC conforming to NEMA RN 1.
- F. Flexible Metal Conduit: Formed from continuous length of spirally wound, interlocked zinc-coated strip steel conforming to UL 1.
- G. Liquid-Tight Flexible Metal Conduit: Constructed of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).
- H. Rigid Metal Conduit Fittings: Cast malleable iron, galvanized or cadmium plated, compatible with conduit materials conforming to NEMA FB-1.
- I. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.
 - 1. Straight Terminal Connectors: One piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

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2. 45° or 90° Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.
- J. Liquid-Tight Flexible Metal Conduit Fittings: Cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat.
- K. EMT Fittings: Galvanized steel fittings, set screw or compression watertight type, except where aluminum EMT is used provide UL listed fittings for use with aluminum EMT.
- L. Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded-conduit-entrance ends, removable covers, either cast or of aluminum or galvanized steel, and corrosion-resistant screws.

2.3 NON-METALLIC RACEWAYS

- A. Electrical Plastic Conduit:
 1. Heavy Wall Conduit: Schedule 40, 90 deg. C, UL-rated, constructed of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or normal above ground use, UL-listed and in conformity with NEC Article 352.
 2. Extra Heavy Wall Conduit: Schedule 80, UL-rated, constructed of polyvinyl chloride compound C-200 PVC conforming to NEMA TC-2, and UL-listed in accordance with NEC Article 352 for direct burial, or above ground use.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3, mate and match to conduit or tubing type and material.
- C. Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes, and materials complying with manufacturer's published product information, which mate and match conduit and tubing.
- D. Conduit and Fitting Bonding: Use only manufacturer's recommended sealing compounds to produce watertight joints.

2.4 WIREWAYS

- A. General: Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as required for a complete system.

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2.5 OUTLET BOXES

- A. Provide galvanized coated flat rolled sheet-steel non-gangable outlet boxes, of shapes, cubic inch capacities, and sizes suitable for installation at respective locations. Provide one piece multiple-gang boxes, not built-up. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom, ends and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover, and with grounding screws for fastening surface and device type box covers, and for equipment type grounding.
- B. Outlet Box Accessories:
 - 1. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliant option. Provide Erico #RBS16 or RBS24 box mounting plate in metal or wood stud partition walls as required where two or three devices are shown mounted side by side such as a receptacle, telecom or other device as indicated.
 - 2. Provide outlet box extension rings of the square-cut tile-type for use in GWB, tile, and wood-paneled walls. Provide standard plaster rings for use in plaster walls.
- C. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet boxes, of types, shapes and sizes suitable for installation at respective locations, with threaded conduit holes for fastening electrical conduit, complete with NEMA 3R covers.

2.6 INTERIOR AND ABOVE-GRADE EXTERIOR JUNCTION AND PULL BOXES

- A. Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation. For exterior above-grade locations, provide NEMA 3R boxes with welded seams and equipped with stainless steel nuts, bolts, screws and washers. If knockouts are provided on the sides of the box for conduit entry, use watertight conduit hubs. Large pullboxes with any dimension over 6 feet shall be complete with built-in wire support systems to prevent wire from pressing on connectors or other wire to prevent damage to insulation. Pullboxes in high-rise installations shall be complete with insulating wedge type connectors to provide proper support of conductors. The number and locations of pullboxes shall be as required by NEC to provide proper support of conductors, where required due to the number of bends in the raceway and where required due to length of raceway to not exceed the maximum pulling tension recommended by the cable manufacturer. Exterior exposed pullboxes shall be provided with screened raintight openings to allow heat to escape.

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2.7 EXTERIOR BELOW-GRADE JUNCTION AND PULL BOXES

- A. Provide exterior below-grade junction and pull boxes at locations indicated and as required. Top of boxes shall be set flush with existing grade. Boxes shall be constructed of polymer concrete and fiber reinforced polyester 3 to 4 times the compressive strength of concrete and having the tensile strength of steel. Boxes shall have full size covers secured to the box with stainless steel pentahead hardware. Covers shall have the logo "ELECTRIC" or "TELECOM" as required. Boxes and covers shall have a heavy duty rating. Boxes shall be sized in accordance with NEC requirements for number of conduits entering and leaving box.

2.8 MISCELLANEOUS CABINETS

- A. Provide flat-rolled sheet-steel cabinets, flush or surface mounted as indicated, hinged door with flush latch and lock. Provide a framed directory with clear plastic protective cover on inside of door; trim clamps; gaskets where required by atmospheric conditions; single point latching for doors under 36"; 3 point latching for doors 36" and larger. Door and trim shall have factory applied finish to match panelboard cabinets.
- B. Fabricate C.T. cabinets from 12 gauge sheet steel; double doors with 3-point latching; NEMA-3R enclosure, gray enamel finish inside and out over phosphatized surfaces; 3/4" thick full size plywood panel installed in cabinet; hasp and staple for padlocking or sealing by the utility company.
- C. Manufacturers: Provide cabinets of one of the following:
 - 1. Anchor
 - 2. Austin
 - 3. Keystone
 - 4. Electromate
 - 5. Hoffman
 - 6. Westinghouse
 - 7. General Electric
 - 8. Square D

2.9 THRU-WALL/FLOOR FIRESTOP DEVICE

- A. The firestop device shall meet UL1479 (ASTM E 814) and bear the U.S. UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls. The device shall also have been tested by Underwriters Laboratories Inc. To UL2043 and determined to be suitable for

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use in air handling spaces. The firestop device shall stop or inhibit the spread of both fire and smoke as required by the IBC for fire and smoke rated partitions and barriers.

- B. Sizes: The firestop device shall be for 2" and 4" trade size EMT conduit.
- C. At each location where conduits and/or sleeves penetrate a fire or smoke rated partition or barrier for a pathway for I.T. cables, provide sufficient quantity of units to completely cover and properly seal all conduits and sleeves.
- D. Installation shall be in strict accordance with
 - 1. Manufacturer's installation instructions.
 - 2. All written and graphic requirements in the test assembly documentation published by the listing agency.
- E. The firestop device shall be the Wiremold FlameStopper. Other acceptable products are Hilti Speed Sleeve, STI EZ-Path and Metacaulk Pass-Thru.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS

- A. Install raceways level and plumb, and maintain manufacturer's recommended clearances.
- B. Coordinate with other work including wires/cables, boxes and panel work as necessary to interface installation of electrical raceways and components with other work.

3.2 INSTALLATION OF CONDUITS

- A. Conduit runs are not shown on floor plans unless specifically noted or indicated otherwise.
- B. Applications:
 - 1. Use rigid steel conduit in moist or damp locations, in hazardous or refrigerated areas, in poured concrete, underground, beneath slab-on-grade and where exposed outdoors.
 - 2. Steel IMC may be used in lieu of rigid steel conduit where permitted by the NEC, except IMC may not be used below-grade, below slab or in slab.
 - 3. EMT may be used for all installations not requiring rigid or IMC conduit. Aluminum EMT may be used at Contractor's option for size 2" through 4", except

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- do not use aluminum EMT or aluminum products in cast-in-place concrete installation or where UL firestop assemblies require steel.
4. Rigid conduit may be steel or aluminum at Contractor's option, except do not use aluminum conduit or aluminum products in cast-in-place concrete installations or where UL firestop assemblies require steel.
 5. Rigid PVC conduit may be used in lieu of rigid steel for conduits installed in poured concrete, underground or beneath slab-on-grade. Convert to metallic conduit at no more than 48" above ground or slab if concealed in wall; otherwise, convert to metallic conduit before exiting ground or slab. Do not use PVC conduit above-grade unless specifically indicated otherwise.
 6. Use PVC-coated rigid conduit and fittings in all highly-corrosive atmospheres.
 7. Use flexible conduit in movable partitions, from outlet boxes to recessed lighting fixtures, and in cells of precast concrete panels.
 8. Use liquid-tight flexible conduit in exterior exposed locations; in moist or humid atmosphere where condensate can be expected to accumulate; in corrosive atmosphere; where subjected to water spray or dripping oil, water or grease; and for connection of motors, transformers and equipment subject to movement and vibration. Wherever liquid-tight flexible conduit is used, it may only be for the final 6 feet (maximum) of a connection to a motor, transformer or piece of equipment subject to movement or vibration.

C. General:

1. Install conduits concealed in new construction work, either in walls, slabs or above hung ceiling, except in mechanical or electrical equipment rooms in which they may be exposed. Install conduits concealed in stairs, except in stairs without suspended ceilings a short horizontal section conduit to feed each light fixture mounted to underside of landing may be exposed. Run conduits concealed in existing work where practicable. Where conduits cannot be concealed in finished areas, notify the Architect for permission to use surface raceways. Where installed at roof decking, follow requirements of NEC 300.4(E).
2. Provide penetration firestopping in smoke barriers and fire-resistance-rated walls, floors and ceilings for electrical raceway penetrations in accordance with Division 7 and with requirements of this section.
3. Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.
4. Avoid use of dissimilar metals throughout systems to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
5. Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion/deflection fittings in raceways every 200' linear run or wherever structural expansion joints are crossed, per NEC 300.4(H).

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6. Provide polypropylene or monofilament plastic or pull cord with not less than 200-lb tensile strength in empty conduits, tied off at both ends. Test conduits required to be installed, but left empty, with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.
7. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.
8. Use factory-made elbows or field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
9. Size conduits to meet NEC, except no conduit smaller than 3/4 inch shall be used unless noted otherwise. Conduits below-grade and in-slab shall be minimum 1 inch.
10. Fasten conduit terminations in sheet metal enclosures by 2 locknuts, and terminate with bushing. Install locknuts inside and outside enclosure.
11. Conduits shall not touch sprinkler pipes, or cross pipe shafts or ventilating duct openings.
12. Keep conduits a minimum distance of 6" from parallel runs of flues, hot water pipes and other sources of heat. Wherever possible, install raceway runs below hot water and steam piping where necessary to cross piping.
13. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
14. Complete installation of electrical raceways before starting installation of cables/wire within raceways.
15. Install conduits so as not to damage the integrity of the structural members. Avoid horizontal or cross runs in building partitions or side walls.
16. Install temporary closures to prevent foreign matter from entering raceways.
17. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
18. Provide bushings on all conduit stubs.

D. Concealed Conduits:

1. Metallic raceways installed underground, in floors, below-grade or outside shall have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.
2. Install underground conduits minimum of 24" below finished grade, except where NEC requires deeper burial.
3. Mark Record Documents with conduit size and location.

E. Conduits in Concrete Slabs:

1. Install conduits in concrete slabs only under the following conditions:
 - a. In slab-on-grade.
 - b. In structural concrete deck.

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- c. In concrete-on-metal deck for short runs to isolated floor outlets.
 2. Place conduits between bottom reinforcing steel and top reinforcing steel in middle 1/3 of slab thickness. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond. Conduits crossing in slab must be reviewed for proper cover by Architect. Minimum finished cover of conduit in slabs shall not be less than one inch. Embedded conduit diameter is not to exceed 1/3 of slab thickness at cross-overs, if any. For locations where a large "swath" of conduits will be in or below slab, coordinate requirements with Structural Engineer before rough-in.
 3. Mark Record Documents with conduit size and location.
- F. Exposed Conduits:
1. Install exposed conduits and extensions from concealed conduit systems parallel with or at right angles to walls and floors of building. Conduits shall be run tight to the wall and ceiling or structure and as neatly and inconspicuously as possible.
 2. Exposed conduits may be used in finished spaces only when conduits cannot be concealed and surface raceway is not practical, and only with the specific approval of the Architect. The Contractor shall submit a detailed proposal for the area and the routing of the exposed conduit to the Architect before installation. Exposed conduits in finished areas shall be painted to match the surface on which they are installed.
 3. Install exposed conduit work so as not to interfere with ceiling inserts, lights, ventilation ducts, HVAC unit clearances, or outlets.
 4. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed the requirements of the NEC. Support multiple runs of conduit from trapeze hangers.
 5. Set anchors in waterproof cement for the support of conduits where run on waterproof walls.
 6. Above requirements for exposed conduits also apply to conduits installed in space above hung ceilings and in crawl spaces.
- G. Non-metallic Conduits: Make solvent cemented joints in accordance with recommendations of manufacturer.
- H. Conduit Fittings:
1. Use locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.
 2. Bushings for terminating conduit smaller than 1-1/4" shall have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
 3. Install insulated type bushings for terminating conduits 1-1/4" and larger. Bushings shall have flared bottom and ribbed sides. Upper edge shall have phenolic insulating ring molded into bushing.

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4. Bushings of standard or insulated type shall have screw type grounding terminal where required by the NEC.
5. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs shall be specifically designed for their particular application.
6. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with U.L. 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:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - b. Where otherwise required by NFPA 70, such as in 225.27 and 300.5(G).

3.3 INSTALLATION OF WIREWAYS

- A. Mechanically assemble metal enclosures and raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings and cabinets in order to provide effective electrical continuity and rigid mechanical assembly.
- B. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
- C. Install expansion fittings in all wireways and raceways wherever structural expansion joints are crossed.
- D. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. No field bends of raceway sections will be permitted.
- E. Properly support and anchor raceways for their entire length by structural materials. Raceways shall not span any space unsupported.

3.4 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. All wall-mounted wiring device boxes shall be mounted with long dimension vertically unless otherwise noted.
- B. Coordinate installation of electrical boxes and fittings with conductors/cable, wiring devices, raceway installation work, and equipment requiring electrical connections.
- C. Provide raintight outlets for interior and exterior locations exposed to weather or moisture.

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- D. Provide surface mounted boxes only where recessed mounting is not possible.
- E. Provide knockout closures to cap unused knockout holes where blanks have been removed in new and existing boxes and fittings.
- F. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- G. Do not install boxes back-to-back in walls, unless “putty pads” are provided for sound attenuation. Back-to-back boxes may be used for switch outlets next to a cased wall opening (no door).
- H. Provide not less than 6" separation between sides of boxes in opposite sides of acoustic walls, unless “putty pads” are provided for sound attenuation.
- I. Provide membrane protection for penetrations of fire rated walls as required by code:
 - 1. Provide not less than 24" separation between sides of boxes in opposite sides of fire rated walls, or
 - 2. Provide Wall Opening Protective Materials (fire putty sheet or similar code-compliant product such as FireBlock Fire Suppression Gasket) for outlet boxes in fire rated walls, or
 - 3. Provide solid fireblocking in accordance with code.
- J. Provide membrane protection for penetrations of fire rated ceilings as required by code:
 - 1. Provide Ceiling Opening Protective Materials (fire putty sheet) for outlet boxes in fire rated ceilings, or
 - 2. Provide solid fireblocking in accordance with code.
- K. Do not install aluminum products in concrete.
- L. Position recessed outlet boxes accurately in order that boxes will not be installed with front edge of box at a greater depth in wall than permitted by NEC. Provide extension rings for existing outlet boxes with new wall covering so face of box is flush with the finished wall surface and finished plate is tight to wall on all sides.
- M. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Box support shall be independent of conduit.
- N. Subsequent to installation of boxes, protect boxes from construction debris and damage.
- O. Install power and communications outlets for televisions so as to be concealed by the television. Coordinate location with the bracing for wall or ceiling brackets and with furniture as recommended by manufacturer.

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END OF SECTION 260533

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Extent of electrical identification work is as herein specified.
- B. Types of electrical identification work specified in this section include the following:
 - 1. Electrical power, control, fire alarm and communication conductors and/or conduits.
 - 2. Operational instructions and warnings.
 - 3. Danger signs.
 - 4. Equipment/system identification signs.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES

- A. Electrical Code Compliances: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to installation of identifying labels and markers for wiring and equipment.
- B. U.L. Compliance: Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to electrical identification systems.
- C. NEMA Compliance: Comply with applicable requirements of NEMA Std. Nos. WC-1 and WC-2 pertaining to identification of power and control conductors.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams and the manuals, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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- 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 the installation of acoustical ceilings and similar concealment.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical identification materials and products.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Contractor's option, but provide single selection for each application.
- B. Color-Coded Plastic Tape: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1/2" wide.
- C. Detectable Underground-Type Plastic Line Marker: Manufacturer's standard permanent, bright-colored, continuous-printed detectable plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.
- D. Self-Adhesive Plastic Signs:
 - 1. General: Provide manufacturer's standard self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings, of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.
 - 2. Colors: Unless otherwise indicated, or required by governing regulations, provide black signs with white lettering.
- E. Baked Enamel Danger Signs: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gage steel with standard red, black and white graphics. Provide following minimum sizes: 20" x 14", 14" x 10", or 10" x 7", where signs are sized according to the largest size which can be applied where needed, or where a larger

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size is needed for adequate vision. Provide signs with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

- F. Cable/Conductor Identification Bands: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap, numbered to show circuit identification.
- G. Engraved Plastic-Laminate Signs:
 - 1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thickness indicated, engraved with engraver's standard lettering style of sizes and wording indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate, and color codes as indicated below:
 - a. Normal Power Systems: Black face with White lettering.
 - 2. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.
 - 3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.2 LETTERING AND GRAPHICS

- A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operations/maintenance of electrical systems and equipment.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install electrical identification products as specified in accordance with the manufacturer's written instructions and the requirements of the NEC.
- B. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of finish work.
- C. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

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- D. Identification: Coordinate all room number designations with the final room numbers. Use final room numbers for all final documentation and display, including but not limited to, programming, alarm displays, annunciator displays, panelboard schedules, signage, labels and engraved labels. The room numbers shall be as directed by the Owner and may not be the same as shown on Contract Drawings. Include final room numbers on the drawings for the Record Documents.

3.2 CONDUIT IDENTIFICATION

- A. Where conduit is concealed above accessible ceilings or exposed, apply color-coded identification at equipment termination, at outlet boxes, pull boxes and junction boxes, within each room, and at 20' on-center within an area.

1. Color-code conduit using plastic tape with the following band colors between orange background bands.

SERVICE	COLOR BAND
240 or 208/120 Volt Normal Circuits	Black
Grounding Electrode	Green
Fire Alarm	Red
Sound/Intercommunication	Purple
Television	Brown
Telephone	Yellow
Telecom	Brown/Yellow
Security	White/Red

3.3 UNDERGROUND CABLE IDENTIFICATION

- A. During backfilling/top-soiling of each exterior underground electrical, signal or communication cable, install a continuous detectable underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker. Install line marker for every buried cable or group of buried cables, regardless of whether direct-buried or protected in conduit.

3.4 CONDUCTOR/CABLE COLOR CODING

- A. See Division 26 for color-coding of line voltage conductors and cables. Provide means of identification per NEC 200.6(D).

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3.5 CONDUCTOR/CABLE CIRCUIT IDENTIFICATION

- A. Apply cable/conductor identification, including panelboard and circuit number on power wiring, on each cable/conductor in each box/enclosure/cabinet. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

3.6 IDENTIFICATION OF UNGROUNDED CONDUCTORS

- A. Where more than one nominal voltage system exists in a building, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system. This means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means and shall be permanently posted at each panelboard and switchboard or readily available in accordance with NEC 210.5.

3.7 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. Operational Identification and Warnings: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets, and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

3.8 DANGER SIGNS

- A. General: In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations identified by Installer of electrical work as constituting similar dangers for persons in or about project.
- B. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
- C. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger of persons, or damage to or loss of property.

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3.9 EQUIPMENT/SYSTEM IDENTIFICATION

- A. Signs: Install engraved plastic-laminate sign on outside of each major unit of electrical equipment in building, including central or master unit of each electrical system, including communication/control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Provide three (3) lines of text, with 1/2" high lettering for first line and 1/4" high lettering for other lines; first line of text shall indicate name of unit, second line of text shall indicate voltage and phase and number of wires, and third line of text shall indicate origin of feeder. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
1. Panelboards, control panels, relay panels, electrical cabinets, and enclosures.
 2. Access panel/doors for concealed electrical items.
 3. Enclosed switches (safety switches) and circuit breakers.
 4. Motor starters (magnetic and manual starters).
 5. Variable frequency drives.
 6. Push-button stations.
 7. Power generating units.
 8. Provide permanent SERVICE ENTRANCE label for all service entrance equipment.
- B. Install signs at locations indicated and, where not otherwise indicated, at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- C. Provide labeling in accordance with all requirements in NEC 110.21 and 110.22.
- D. Provide fault current labeling on service equipment per NEC 110.24(A).
- E. Provide enclosure type labeling as required in NEC 110.28.
- F. Provide label on each fire alarm control panel and power supply clearly indicating the branch circuit feeding it.
- G. Provide labeling for industrial control panels per NEC 409.110.

END OF SECTION 260553

SECTION 260573 - SHORT-CIRCUIT COORDINATION STUDY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the requirements of the “Study”, which is a computer generated analysis of the designed, manufactured, and installed electrical distribution system. The analysis shall include short-circuit coordination as described below.
- B. This Contractor shall include a complete study in the bid. The bid shall include all revisions necessary to achieve a complete study that is accurate per the construction documents plus all accepted study recommendations – change orders to provide revised studies based on the bid documents will not be approved.
- C. This study shall include short-circuit analysis for all panelboards, enclosed switches and circuit breakers, and magnetic motor starters. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to Division 26 requirements for study requirements.

1.4 DATA COLLECTION FOR THE STUDY

- A. The Contractor shall provide the required data for preparation of the study. The Engineer performing the system study shall furnish the Contractor with a listing of the required data immediately after award of the contract to the Engineer performing the study.
- B. The Contractor shall expedite collection of the data to assure completion of the study as required for final approval of the electrical distribution equipment submittals and/or prior to release for manufacturing.

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1.5 SUBMITTALS

- A. Qualifications: Submit qualifications for approval prior to commencement of the study for the Professional Engineer that will perform the study.
1. The study shall be prepared by a qualified Professional Engineer from the electrical distribution manufacturer or approved consultant that is currently involved in high-and low-voltage power system evaluations and has a minimum of three (3) years of experience in power systems coordination and analysis.
 2. The Professional Engineer shall be registered in the State of Virginia and shall stamp, sign, and date each study submittal.
 3. The firm or Professional Engineer performing the study shall demonstrate capability and experience to provide assistance during start up as required.
- B. Required Study Submittals:
1. Design Submittal: This submittal shall include the electrical distribution system as designed on contract documents utilizing electrical distribution equipment from manufacturers being submitted.
 - a. Prior to this submittal the Engineer performing the study shall:
 - (1) Submit qualifications for review and approval.
 - (2) Provide the Contractor with a list of all required data needed to perform the study.
 - b. Prior to this submittal the contractor shall provide:
 - (1) The conductor submittal for review and approval.
 - (2) All required data needed by the Engineer performing the study. This includes coordinating with local utility company to determine the available fault current at the service entrance pad mounted transformer. Also obtain all transformer characteristics required by the Engineer performing the study.
 - c. This submittal shall be submitted to the Design Engineer along with the electrical distribution equipment submittals.
 - d. This submittal shall include recommendations on how to correct any portion of the study that does not coordinate. Provide time curves that demonstrate how these recommendations resolve the coordination issues.
 - e. Approval of the electrical distribution equipment will be dependent on the approval of the study, which is typically approved during the CA Submittal. Prior to releasing the electrical distribution equipment for manufacturing

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both the study and the electrical distribution equipment submittals are required to be approved.

- (1) If approval of the study may cause delay in equipment manufacturing thereby causing a delay in the project schedule, preliminary approval from the Design Engineer of this Design Submittal may be obtained. Preliminary approval will depend on the conditions of the Design Submittal and whether or not sufficient study data was provided to ensure that the selection of device ratings and characteristics will be satisfactory.
 - (2) A preliminary approval does not alleviate the requirements for submitting the CA and Final Submittals below.
2. CA Submittal: This submittal shall include all marked up revisions from the Design Submittal along with all revisions to the electrical distribution equipment associated with their first submittal mark ups, all changes per approved submittals from all other disciplines, and all changes to contract documents per addendum, requests for information, requests for proposal, and/or review/field comments from AHJ.
- a. Prior to this submittal the contractor shall:
 - (1) Review all approved submittals from all disciplines for any changes to the electrical distribution equipment. Notify Design Engineer of any changes not already addressed in the approved submittals from the other disciplines.
 - (2) Review all addendums, requests for information, request for proposals, and review/field comments from AHJ for any changes to the electrical distribution equipment.
 - (3) Coordinate with the manufacturer(s) of the electrical distribution equipment to include all marked up comments in the review of the Design Submittal, the distribution equipment submittal, and all changes associated with approved submittals from all other disciplines. If required, resubmit the electrical distribution equipment with the CA Submittal for review and approval.
 - b. Prior to this submittal the Engineer performing the study shall:
 - (1) Coordinate with the contractor for any outstanding data that still needs to be collected. All data shall be finalized for this submittal.
 - (2) Notify Design Engineer of any equipment that does not coordinate. Work with Design Engineer to resolve all un-coordinated equipment.
 - c. This submittal shall be submitted to the Design Engineer along with any submittals showing changes to the electrical distribution equipment.

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- d. Where this submittal is approved, the electrical distribution equipment will be capable of being approved to be released for manufacturing if the equipment submittals are approved.
3. Final Submittal: This submittal shall include all final changes to the electrical distribution equipment associated with the As-Built conditions.
 - a. Prior to this submittal the contractor shall:
 - (1) Review all addendums, requests for information, requests for proposals, and review/field comments from AHJ for any changes to the electrical distribution equipment.
 - (2) Provide the Engineer performing the study all As-Built changes to include into the study.
 - b. Prior to this submittal the Engineer performing the study shall notify Design Engineer of any equipment that does not coordinate. Work with Design Engineer to resolve all un-coordinated equipment.

1.6 REFERENCES AND CODES

A. Short-Circuit Coordination:

1. 2014 NFPA 70: National Electrical Code (NEC):
 - a. Article 110.9 – Interrupting Rating
 - b. Article 110.10 – Circuit Impedance, Short Circuit Ratings, and Other Characteristics
 - c. Article 240.12 – Electrical System Coordination

PART 2 - PRODUCTS

2.1 SHORT-CIRCUIT COORDINATION STUDY

- A. The study shall be performed by means of a computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.
- B. Short-Circuit Coordination: Provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each distribution panelboard, pertinent branch circuit panelboard and other

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significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, 3-phase motor fault contribution 25hp and larger (coordinate with other Divisions for motor data), short circuit KVA and symmetrical and asymmetrical fault currents. Do not “lump” motors together.

- C. Include complete fault calculations as specified herein based on contract documents.
- D. Notify Design Engineer in writing of circuit protective devices not properly rated for fault conditions.
- E. Mechanical Contractor to provide settings for VFD's and/or motor starters that are furnished as part of the mechanical equipment.

2.2 STUDY REPORT

- A. The results of the study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted, or it shall be submitted electronically.
- B. The report shall include the following sections:
 - 1. Descriptions, purpose, bases and scope of the study.
 - 2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties and commentary regarding same.
 - 3. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
 - 4. One-line riser diagram of the entire electrical distribution system or the portion(s) of the system included in the study. Provide the name of the equipment as is designated on the contract documents. Provide the size, type (AL or Cu), and quantity of the feeders next to each feeder. Provide the frame size (amps), Trip setting (amps), fault current rating, and calculated fault current next to each overcurrent protective device. Provide the KVA rating and calculated fault current next to each transformer. Include the voltage and phase next to each piece of equipment. Provide horsepower rating of each 3-phase motor.

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PART 3 - EXECUTION

3.1 POWER COMPANY OR LOCAL CODE ENFORCEMENT AUTHORITY APPROVAL

- A. Where required, copies of the final report shall be submitted to the power company and/or local code enforcement authority for their review and approval. Approved copies of the report shall be submitted to the Design Engineer.

3.2 FIELD SETTINGS

- A. A factory-authorized representative shall perform field adjustment of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the schedule of all adjustable breakers provided in the approved study. Contractor shall notify Design Engineer once all breakers have been adjusted for field verification approval. Once all breaker settings have been field verified and approved by the Design Engineer the contractor shall provide and install all necessary locking devices over the covers to the adjustable setting on the breakers. All settings shall be required to be locked so that they cannot be tampered with by unqualified personnel.
- B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved study shall be carried out by the Contractor at no additional cost to the Owner.

END OF SECTION 260573

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SECTION 260583 - WIRING CONNECTIONS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the basic requirements of electrical connections for equipment specified in Division 8, 10, 11, 12, 13, 14, 21, 22 and 23 sections and Division 26, 27 and 28 sections making reference to electrical connections for equipment specified herein.
- B. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES

- A. Refer to other Division 26 sections for motor starters, controllers and disconnects not furnished as integral part of equipment.
- B. Refer to sections of other Divisions for motor starters, controllers, VFD's and disconnects furnished integrally with equipment and for specific individual equipment power requirements.
- C. Refer to other Division 26 sections for junction boxes, raceways and conductors/cables required for connecting motors and other electrical units of equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refer to other Division 26 sections for manufacturers of electrical connection products.

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2.2 MATERIALS AND COMPONENTS

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, junction boxes, raceways, conductors/cables, disconnect switches, starters, controllers, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wirenuts, and other items and accessories as needed to complete splices, terminations, and connections.
- B. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals as recommended by equipment manufacturer for intended applications.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Connect electrical power supply conductors to equipment conductors or terminals in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- B. Cover splices with electrical insulating material equivalent to or greater than electrical insulation rating of those conductors being spliced.
- C. Prepare cables and conductors by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" conductors while stripping wire.
- D. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- E. Tighten connectors and terminals, including screws and bolts, in accordance with the equipment manufacturer's published torque tightening values for equipment connectors.

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- F. Fasten identification markers to each electrical power supply conductor/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.3 CONNECTIONS TO EQUIPMENT

- A. Final electrical connections to equipment furnished under other sections of these specifications or specified to be furnished by the Owner shall be provided as required for the individual item of equipment. Provide the conduit, outlet boxes, and power wiring from the power source to the motor or equipment junction box, wiring devices, transformers, relays, starters, VFD's, disconnect switches or circuit breakers, including wiring through starters, VFD's or safety switches, in accordance with the manufacturer's installation instructions. The presumed location of all presently envisioned equipment having electrical connections is shown or scheduled, but these locations are for estimating purposes only and the contractor shall prepare the bid to allow for any possible rearrangement of the equipment listed or as shown or scheduled. Prior to roughing in conduit, receptacles, or other outlets or equipment, verify the locations and characteristics of equipment and verify heights and locations of required connections from an approved shop drawing or roughing-in drawing. Use roughing-in dimensions of electrically operated units furnished by the supplier.
- B. Provide connections for, but not limited to, the following equipment as specified:
 - 1. Mechanical and Plumbing Equipment: See Divisions 21, 22 and 23 for any type or item of equipment requiring electrical connections. Provide all power wiring and control wiring of 110 volts and greater for controlling all equipment as described therein even though control wiring may not be shown on Electrical Drawings. See Mechanical Drawings for exact locations of equipment and Mechanical Specifications for control of equipment.
 - 2. Outdoor Signs: Provide electrical circuits, junction boxes and controls for the exterior signs on the building or located on the site as indicated. Junction boxes shall be located as directed by the sign supplier. Provide low-voltage control wiring conduit(s) to the signs, to be terminated as directed on the job by the sign supplier. Comply with all requirements of NEC Article 600.

3.4 FIELD QUALITY CONTROL

- A. Final connections and proper operation of equipment connected under this contract shall be supervised by the equipment supplier. This Contractor shall certify in writing to the Architect that the connected equipment is properly connected and the equipment is operating properly in accordance with these contract specifications, the equipment

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manufacturer's wiring diagrams, and instructions of the equipment supplier or manufacturer.

END OF SECTION 260583

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SECTION 260943 - LIGHTING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of automatic and manual lighting controls (except for line-voltage toggle switches and line-voltage wallbox dimmers). The extent of the lighting controls work is indicated by drawings and schedules and as specified herein.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to other Division 26 sections for conductors / cables, grounding, raceways, electrical boxes and fittings and wiring devices required in connection with lighting controls.
- B. Refer to Section 26 27 26 for line-voltage wall-box dimmers and for line-voltage toggle switches.

1.4 REFERENCES AND CODES

- A. Electrical Code Compliances: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to installation and construction of lighting controls
- B. Underwriters Laboratories (UL):
 - 1. 508 – Standard for Industrial Control Equipment.
 - 2. 924 – Emergency Lighting and Power Equipment.
 - 3. 1008 – Transfer Switch Equipment
 - 4. 1472 – Standard for Solid-State Dimming Controls.
- C. All 0-10V dimming controls shall comply with IEC 60929.

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1.5 SUBMITTALS

- A. Submit manufacturer's standard catalog data for each of the products specified. Include data on features, components, ratings and performance, including coverage patterns for each type of sensor. Include dimensioned drawings with isometric projections of components and enclosures.
- B. Provide samples of the equipment, devices and device wall plates for color selection and evaluation of technical features, if required by the Architect.
- C. Provide wiring diagrams detailing internal and interconnecting wiring for power, signal and control that distinguishes between field-installed and factory-installed wiring.

1.6 QUALITY ASSURANCE

- A. Manufacturer shall be regularly engaged in manufacturing of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. All devices shall be U.L. and CSA Listed specifically for the required loads.
- C. Lighting controls shall be listed, approved and comply with all national, state and local energy codes, including but not limited to ASHRAE 90.1-2010 and the 2015 IECC.
- D. Comply with NEC and all local and state codes as applicable to electrical wiring work. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems and manufacturer specifications.
- E. Manufacturer shall maintain ISO 9001-2000 quality standard certification, including in-house engineering for product design activities.

1.7 WARRANTY

- A. The manufacturer shall provide a full one-year warranty (minimum) on all equipment provided and installed under this section.
- B. Warranty information and documentation shall be included in Submittals and Operation and Maintenance manuals turned over to owner at end of project.

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PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Exterior photoelectric switch (photocell) based on Tork; acceptable equals by Intermatic and Precision.
- B. Lighting Contactor based on Square D; acceptable equals by General Electric, Eaton and Siemens.
- C. Interior low-voltage wired sensors and switches based on Lutron; acceptable equals by Hubbell, Wattstopper, Acuity, Eaton Greengate and Crestron.
- D. Interior standalone wireless sensors and switches based on Lutron; acceptable equals by Wattstopper, Acuity and Crestron.

2.2 EXTERIOR SENSORS

- A. Exterior Photoelectric Switch (Photocell):
 - 1. Solid state with SPST dry contacts rated for 2000 VA tungsten or 1800 VA inductive, complying with UL 773A. Voltage shall be 120V.
 - 2. Light-Level Monitoring Range: 1 fc to 15 fc with adjustable turn-on and turn-off levels; integral slide for light level adjustment.
 - 3. Time Delay: 120 seconds maximum.
 - 4. Cell: Cadmium sulphide, epoxy coated, 1 inch diameter.
 - 5. Mounting: Die cast zinc with 1/2 inch conduit mounting; accessories as required.

2.3 LIGHTING CONTACTORS

- A. Provide multi-pole lighting contactors with maximum continuous ampere rating and number of poles as indicated on drawings; contacts 100% rated for ballast and tungsten lighting and resistance loads; mechanically held, electrically operated; suitable for 120 volts, single phase, 60 HZ with coil voltage of 24 volts; field-convertible, silver-cadmium-oxide double break contacts. Install contactors in a NEMA-1, surface-mounted enclosure. Provide auxiliary relay for 2-wire control, and provide HOA switch with pilot light in enclosure cover. Provide other accessory devices where indicated.

2.4 INTERIOR LOW-VOLTAGE WIRED SENSORS AND SWITCHES

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- A. See schedule on drawings for interior ceiling and/or wall mounted low-voltage sensors, manual switches and load controllers. Connect per manufacturer's recommendations for individual room/area operation (lighting zoned per the floor plans). Controls shall be standalone, and not networked as a total building system; provide all programming tools needed for Owner to be able to re-program standalone rooms in the future; basis of design is Lutron, with acceptable equal manufacturers as indicated on the drawings.
- B. For manual switches, match wall mounted switch color and wallplate color/material to wiring devices and wallplates as specified in Section 26 27 26 or as directed by Architect or Engineer. Wall plates shall be by the same manufacturer as the wiring devices wall plates.
- C. Provide all dimming modules necessary (line-voltage, phase-cut, 0-10V, etc.).

2.5 INTERIOR STANDALONE WIRELESS SENSORS AND SWITCHES

- A. See schedule on drawings for interior ceiling and/or wall mounted wireless sensors and manual switches. Connect per manufacturer's recommendations for individual room/area operation (lighting zoned per the floor plans). Provide minimum load controllers (MLC's) if necessary for proper operation.
- B. For manual switches, match wall mounted switch color and wallplate color/material to wiring devices and wallplates as specified in Section 26 27 26 or as directed by Architect or Engineer. Wall plates shall be by the same manufacturer as the wiring devices wall plates.

2.6 VARIOUS

- A. For all low-voltage controls, provide what is necessary for the Owner to make programming changes to the system after all initial programming has been performed by the manufacturer. This may be accomplished by a PC, a handheld programmer, or other means, as long as the Owner can easily make programming/setting changes at any time after initial programming without needing to contact a manufacturer's representative.
- B. For all 0-10V dimming controls, the performance curves for the 0-10V control and the 0-10V drivers shall not both be logarithmic. All 0-10V dimming controls shall include a relay in order to turn the circuit completely off.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. The Lighting Control equipment shall be installed and connected as indicated on the drawings and as directed by the manufacturer. The Contractor shall complete all electrical connections to all control circuits, sensors, devices, etc.
- B. All wiring shall be in accordance with the manufacturer's specifications. Wiring shall meet all local and state codes. All wiring shall be ground and short tested.
- C. Low-Voltage Cabling (including 0-10V): All low-voltage wiring/cabling shall be wired as Class 2 or Class 3 as applicable, following all requirements in NEC 725 for Class 2 or Class 3 circuits as applicable. Low-voltage wiring/cabling shall not share raceways with line-voltage wiring except where allowed by NEC 725.136(I), and all low-voltage wiring/cabling sharing a raceway shall have the same insulation rating. Cables shall be exposed where above A.C.T. ceilings - provide J-hooks spaced 6'-0" apart down corridor walls and D-rings spaced 6'-0" apart on structure where cables run from one side of the corridor to the other. Where J-hooks and D-rings are not required, cables shall be neatly and properly supported from the structure (not ductwork, piping or conduit) in such a way that they will not be strained as the building settles. Where cables are not above A.C.T. ceilings, provide raceways for cables according to Division 26 raceway requirements. Where cables must pass through partitions (such as floors or walls), provide conduit sleeves sized as required and bushed at both ends - cables are not allowed to poke through partitions. No conduit or sleeve shall be smaller than 3/4". Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals.

3.2 SENSOR INSTALLATION

- A. Install and aim occupancy/vacancy 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. Contractor shall install sensors (occupancy/vacancy and photo) in locations and quantities as recommended by manufacturer. Regardless of quantities and locations of sensors shown on drawings, contractor shall provide sensors in quantities and locations to sufficiently cover areas in which sensors are located. If the engineer deems during a field inspection that there is not sufficient coverage or that photosensors are not properly reading the natural light in the space, the contractor will be responsible for adding and/or relocating sensors at no cost to the owner.

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3.3 FIELD QUALITY CONTROL

- A. The contractor or manufacturer's representative shall perform the following functional testing in the presence of the Engineer (notify the Engineer at least 10 days in advance of the start of testing, and certify in writing that the system is fully functional and operating correctly at least 10 days before the functional testing begins):
1. Ensure that control hardware are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
 2. Confirm that the placement, sensitivity and time-out adjustments for occupancy/vacancy sensors yield acceptable performance, and that lights turn off only after space is vacated (or are manually turned off) and do not turn on unless the space is occupied (and are manually turned on for vacancy sensors).
 3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space.

END OF SECTION 260943

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SECTION 262100 - ELECTRICAL SERVICE ENTRANCE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the basic requirements of electrical installations for the electrical service entrance. Extent of the work shall be as indicated on drawings and schedules and as required by the NEC.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to other Division 26 sections for conductors and cables, raceways and electrical boxes and fittings required in connection with the service entrance, as well as the short circuit/coordination study.
- B. Refer to other Division 26 sections for additional service entrance equipment not specified in this section.

1.4 REFERENCES AND CODES

- A. Electrical Code Compliances: Comply with the requirements of the local electrical utility company and applicable requirements of the 2014 NFPA-70 (NEC) pertaining to construction and installation of service entrances.

1.5 WORK INCLUDED, BUT NOT LIMITED TO

- A. Contractor to schedule and coordinate all service entrance requirements with the local utility company.
- B. Install meter base (socket/enclosure) furnished by utility company.
- C. Provide and install 1-1/2" raceway and pull string between service entrance rated panelboard and meter base outside for meter control wiring by Utility Co.

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- D. Provide trenching and backfilling for primary conduits.
- E. Provide and install primary conduits with pull strings.
- F. Provide trenching and backfilling for secondary conduits.
- G. Provide secondary conduits from pad-mounted service transformer to service entrance equipment. Provide terminations in the service entrance equipment.
- H. Provide and install building ground electrode system.
- I. Provide and install concrete pad for utility company pad-mounted service transformer. Coordinate with utility company for required size of concrete pad base on the size of the transformer the utility company is providing.

1.6 WORK NOT INCLUDED

- A. Utility Co. to provide and install pad-mounted service transformer.
- B. Utility Co. to provide and install metering transformers CT's.
- C. Utility Co. to provide meter base (socket/enclosure).
- D. Utility Co. to provide and install meter.
- E. Utility Co. to provide and install meter control wiring and connections between CT's and meter.
- F. Utility Co. to provide and install primary and secondary conductors.
- G. Utility Co. to provide primary and secondary terminations at the pad-mounted service transformer.
- H. Utility Co. to provide and install all grounding at their pad-mounted service transformer.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE EQUIPMENT

- A. General: Provide service equipment which is U.L. listed as service equipment.

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- B. Service equipment rated 600 volts or less shall be marked to identify it as being suitable for use as service equipment.
- C. Short Circuit Current Ratings: This Contractor shall contact the local power company to determine the available fault current at the pad mounted transformer. Utilize components which are individually rated not less than the short circuit current rating as determined from data received from the local power company and from data received from the short circuit/coordination study.
- D. Service Entrance Rated Safety/Disconnect Switches: Provide service entrance rated safety switches in accordance with Division 26 of these specifications.

PART 3 - EXECUTION

3.1 INSTALLATION OF SERVICE ENTRANCE EQUIPMENT

- A. Coordinate with other electrical work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work.
- B. Install fuses, if any, in service-entrance equipment.
- C. Install ground-fault protection (GFP) devices complying with electrical winding polarities indicated as required by NEC 230.95
- D. Set field-adjustable GFP devices and circuit breakers for pickup and time-current sensitivity ranges as required from data received by the short-circuit/coordination study, subsequent to installation of devices and circuit breakers. Provide performance testing for ground-fault protection system as required by NEC 230.95 (C).

END OF SECTION 262100

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of the panelboards. Extent of panelboard work is indicated by drawings and schedules and as specified herein.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to Division 26 for requirements of panelboards used as service entrance equipment, as well as for the short circuit/coordination study.

1.4 REFERENCES AND CODES

- A. Electrical Code Compliances: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to installation, and construction of electrical panelboards and enclosures.
- B. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
- C. U.L Compliance: Comply with applicable requirements of UL 67, "Electrical Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories and enclosures. Provide units which are U.L. Listed and labeled.
- D. Special-Use Markings: Provide panelboards, constructed for special-use, with appropriate UL listing for service entrance equipment, if panelboard is used as service entrance equipment.
- E. NEMA Compliance: Comply with NEMA Stds. Pub. No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," Pub. No. PB 1, "Panelboards," and Pub.

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No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's data on panelboards.
- B. Shop Drawings: Submit manufacturer's drawings indicating the following:
 - 1. Dimensional data, including gutter dimensions.
 - 2. Circuit protective device schedule indicating type, frame, trip, interrupting rating; circuit numbering and arrangement to match that indicated on contract drawings as much as possible.
 - 3. Bus rating and bracing.
 - 4. Lug location and capacity.
 - 5. Provisions for future, breakers or switches.
 - 6. Caution Label in Panelboards with Ground Fault and/or Arc Fault circuit breakers to read "DO NOT INSTALL SHARED NEUTRALS ON GROUND FAULT OR ARC FAULT CIRCUIT BREAKERS".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with all requirements, panelboards shall be manufactured by one of the following:
 - 1. Eaton Corporation/Cutler-Hammer.
 - 2. Siemens Energy & Automation, Inc.
 - 3. Square D/Schneider Electric.
 - 4. General Electric Company

2.2 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; designed and constructed in accordance with published product information; equipped with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated. Panelboards and circuit protective devices shall be marked to indicate that terminal

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provisions are based on the use of 75 degrees C rated, insulated conductors for all terminations.

- B. Panelboards: Provide dead-front safety type panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown; with anti-turn solderless mechanical type lug connectors suitable for copper or aluminum conductors. Provide copper phase bus bars and full-sized neutral bus bars, unless noted otherwise. Ground bus bars shall be un-insulated and bolted to the inside of the enclosure. All bus bars (phase, neutral and ground) shall be of the same material. Only a single neutral or ground conductor is permitted to be connected to a lug screw in the respective neutral or ground bus bar within a panelboard. Provide additional or larger capacity neutral or ground bus bars for each panelboard where indicated. Provide spaces with all studs, bussing, and hardware for future circuit breakers without the necessity of installing additional parts or changing bussing.
- C. Panelboard Enclosures: Unless noted otherwise, provide galvanized sheet steel cabinet type enclosures, code-gauge, minimum 16-gauge thickness, minimum size 5-3/4" deep x 20" wide. Construct with multiple knockouts and wiring gutters. Provide front with hinged trim constructed of piano hinge down one side and adjustable trim clamps. Front shall have an integral door with keyed flush lock/latch and concealed hinges to provide access to the dead front portion of the circuit breakers and screws to release entire trim. Removing screws shall allow entire front to open along with integral door to provide full access to all wiring gutters without removing front. All panelboard enclosures shall be keyed alike. Equip with interior circuit-directory frames and cards with clear plastic covering. Fronts for flush mounted panelboards shall overlap cabinet by 3/4" all around; fronts for surface mounted panels shall be the same size as the cabinet. Provide baked gray enamel finish over rust inhibitor covering, except panels in all finished areas shall have a prime finish, ready for paint finish to match adjacent surface. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed.
- D. Circuit Protective Devices:
 - 1. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
 - a. 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.
 - b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - c. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

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- (1) Instantaneous trip.
 - (2) Long- and short-time pickup levels.
 - (3) Long- and short-time time adjustments.
 - (4) Ground-fault pickup level (only where specifically indicated), time delay, and I²t response.
- d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - e. Ground Fault Circuit Breakers (GFCI): Single-pole and two-pole configurations with a nominal 5 mA trip threshold and 0.025 sec trip time.
 - f. Ground Fault Equipment Protector (GFEP): Single-pole, two-pole and three-pole configurations with a nominal 30 to 300 mA trip threshold.
 - g. Arc Fault Circuit Breaker (combination type per NEC): Single pole and two-pole configurations with detection of line-to-neutral arcing at 75A and above and line-to-ground arcing at 5A and above.
2. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - b. Ground Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature and ground-fault indicator.
 - c. Arc Fault Protection: Combination type AFCI breaker, push-to-test feature and arc-fault indicator.
 - d. Shunt Trip: 120V trip coil energized from separate circuit.
 - e. Multipole units enclosed in a single housing or factory-assembled shall operate as a single unit.
 - f. Fused Switch: NEMA KS 1, Type HD; clips shall accommodate specified fuses; lockable handle. Fuses are specified in Division 26 Section "Fuses".
- E. Short Circuit Current Ratings: This Contractor shall contact the local utility company to determine the available fault current at the pad mounted transformer. Utilize components which are individually rated not less than the short circuit current rating as determined from data received from the local utility company and from the short circuit/coordination study. Series rating is not acceptable. Short circuit current rating shall be as required above and shall be a minimum of 10,000 amps on 208/120 or 240 panels and 14,000 amps on 480/277 panels unless noted otherwise.
 - F. Circuit Breaker Lock: Provide approved circuit breaker lock-on device for the following equipment:

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1. All Fire Alarm System equipment, including but not limited to Fire Alarm Control Panel and remote (NAC) panels. Breakers shall be red and identified as "FIRE ALARM CIRCUIT".
 2. Sprinkler System: Dry-pipe air compressor.
 3. Exit signs.
 4. Egress lighting fixtures.
 5. Other equipment as shown on the Drawings or as required.
- G. Panelboard Surge Protective Device (SPD): See specification section 26 43 13 SURGE PROTECTIVE DEVICES (SPD) for SPD requirements.

PART 3 – EXECUTION

3.1 INSTALLATION OF PANELBOARDS

- A. Coordinate installation of panelboards and enclosures with cable and raceway installation work.
- B. Provide double neutral conductors for panelboards where indicated on the drawings.
- C. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure and plumb. Mount recessed panelboards with front uniformly flush with wall finish.
- D. Provide properly wired electrical connections within enclosures.
- E. Type panelboard's circuit directory card upon completion of installation work. Indicate panel designation, phase, voltage, and (for each circuit) type of load and location on the directory. Use Owner's room numbers, not those on the construction documents.
- F. Unless noted otherwise on the drawings, all adjustable trip breakers shall have their long-time pick-up set to 100%. For breakers that have long-time pick-up set to less than 100%, provide label indicating what the setting is and that the wiring has been sized for this; also provide restricted access per NEC 240.6(C). A factory-authorized representative shall perform field adjustment of protective devices as required to place the equipment in final operating condition. Contractor shall notify Design Engineer once all breakers have been adjusted for field verification approval.
- G. Install filler plates in unused, open circuit breaker spaces.
- H. For flush mounted panelboards, stub four 1-inch empty conduits from panelboard up into accessible ceiling space or space designated to be ceiling space in the future. Also,

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stub four 1-inch empty conduits down into raised floor space or below slab when not on grade. Bush the ends of the conduits.

- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- J. Apply sealant around all exterior mounted panelboards to provide weatherproofing and pest control; refer to sections of Division 7.
- K. Provide equipment/system identification nameplates complying with Division 26 in accordance with panelboard schedules on drawings. Inside each panelboard, the voltage, system, amperage and AIC ratings must be clearly labeled.
- L. Provide field marking to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. Provide arc flash warning label made of high performance polyester, 3-1/2"H X 5"W, Brady Cat. No. 94913 or approved equal

3.2 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Prior to energization:
 - 1. Upon completion of installation, inspect interior and exterior of panelboard.
 - 2. Remove paint splatters and other spots inside and outside of the panelboard enclosure. Repair exposed surfaces to match original finish.
 - 3. Remove all wrenches, packing materials, and construction debris from inside the panelboard.
 - 4. Use vacuum (with non-metallic attachments) to collect loose dust, dirt, and particles from inside the panelboard enclosure and around the exterior of the panelboard enclosure.
 - 5. Do not use compressed air to assist in cleaning. Using compressed air is likely to spread contamination and damage insulation.
 - 6. Accumulated dirt, oil, or grease might require a solvent to be removed. Solvents used for cleaning of electrical equipment shall be selected carefully to ensure compatibility with materials being cleaned. Do not use any liquid cleaners, include spray cleaners, unless specified by the panelboard manufacturer, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of the insulation surfaces. Allow sufficient time for drying after cleaning panelboard with solvents. Wear the required PPE when working with potential hazardous solvents; refer to solvent material data sheets.

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3.3 FIELD QUALITY CONTROL

- A. Prior to energization:
 - 1. Prior to energization of panelboard, check all accessible connections to manufacturer's tightening torque specifications.
 - 2. Prior to energization of panelboard, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
 - 3. Prior to energization of panelboard, check for electrical continuity of circuits and for short-circuits.
- B. Certification: This Contractor shall certify in writing to the Architect that the above checks were made, including date of the checks and results.
- C. Upon completion of installation, energize panelboard and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance, otherwise remove and replace with new units and retest.

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES AND MISCELLANEOUS EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of wiring devices and miscellaneous equipment. The extent of this work is indicated by drawings and in these specifications

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to other Division 26 sections for requirements for electrical installations, conductors and cables, grounding and bonding, and raceway and boxes which are required in conjunction with wiring devices and miscellaneous equipment.

1.3 REFERENCES AND CODES

- A. Electrical Code Compliance: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to installation and wiring of electrical wiring devices.
- B. U.L. Compliance: Comply with applicable requirements of UL 20, 486A, 498 and 943 pertaining to installation and wiring devices. Provide wiring devices which are U.L. Listed and U.L. Labeled.
- C. IEEE Compliance: Comply with applicable requirements of IEEE Std. 241, "Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to electrical wiring systems.
- D. NEMA Compliance: Comply with applicable portions of NEMA Stds. Pub. Nos. WD 1, "General Purpose Wiring Devices", and WD 5, "Specific Purpose Wiring Devices".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on wiring devices and miscellaneous equipment, including manufacturer's standard colors, descriptive literature and recommended installation instructions on each electrical item specified. Mark wiring device cut sheets for applicable NEMA, U.L. and Federal Specification compliance.

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- B. Samples: Submit samples of the following items as requested by Architect or Engineer:
1. Toggle switch, SPST and cover plate.
 2. Weatherproof receptacle cover plate.
 3. Weatherproof switch cover plate.
 4. Tamper-resistant duplex receptacle.
 5. Foam gasket.
 6. Receptacle guard.
 7. Manufacturer color samples for each wiring device and each cover plate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide wiring devices of one of the following:
1. Receptacles and Switches: Bryant, Eaton Arrow/Hart, Hubbell, Leviton, Pass & Seymour.
 2. Wallplates: Bryant, Eaton Arrow/Hart, Hubbell, Leviton, Pass & Seymour.

2.2 WIRING DEVICES

- A. General:
1. Provide factory-fabricated wiring devices, of types and electrical ratings for applications indicated. Color selections for all wiring devices and plates shall be from manufacturer's standard white, ivory, light almond, gray, red, brown or black colors, verified with the Architect by the Contractor (except where colors are noted below) before device order is released. The selected color or colors may not be the same in all spaces in the project.
 2. Wiring devices shall be grounding type and shall be industrial specification grade, construction specification grade or heavy-duty specification grade. Switches shall comply with Federal Specification Standard WS-896 and receptacles shall comply with U.L. Standard 498 and Federal Specification WC-596.
 3. When used in this specification section, the term "unfinished" refers to mechanical rooms, electrical rooms, I.T. rooms, storage rooms, shops and janitor's closets. Unless otherwise indicated, all other interior spaces shall be considered "finished".
- B. Receptacles:
1. Duplex: Provide duplex receptacles with non-tracking thermoplastic polyester and/or nylon case; color as selected by Architect in finished and unfinished

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- spaces; red for receptacles connected on emergency circuits; blue for surge suppression receptacles; triple-wipe power contacts .031 in. nominal; break-off tab for split wiring; auto-grounding clip; metal plaster ears; side wiring with spring-loaded, screw-activated pressure plate; NEMA configuration 5-20R, unless otherwise indicated. Provide isolated ground receptacle with orange triangle on face where indicated or required. Receptacles shall be straight blade style.
2. Ground Fault Duplex: Provide ground fault duplex receptacles with non-tracking thermoplastic polyester and/or nylon case; color to match duplex receptacles in same area; red for receptacles connected on emergency circuits; side wiring with spring-loaded, screw-activated pressure plate; "feed-through" type capable of protecting connected downstream outlets; grounding type UL-rated Class A, Group 1; solid-state ground fault sensing and signaling with 5 milliamperes ground-fault trip level; NEMA configuration 5-20R, unless otherwise indicated. Receptacles shall be straight blade style.
 3. Tamper Resistant Duplex: Provide duplex receptacles with mechanical shutter mechanism to prevent access to contacts unless a two-pronged plug is inserted; non-tracking plastic or nylon case; face locked into base; "TR" symbol stamped on receptacle face; color to match duplex receptacles in same space type, except red where on emergency circuit; metal plaster ears; side wiring with spring-loaded, screw-activated pressure plate; NEMA configuration 5-20R, unless otherwise indicated. Receptacles shall be straight blade style.
 4. Provide receptacles requiring current, voltage or configuration different from duplex receptacles as indicated. Provide with quality, material and workmanship at least equal to that specified for duplex receptacles.
- C. Plugs: Provide plugs where noted or required, grounding-type, adjustable cord clamp, NEMA configuration and blades to match receptacle where noted.
- D. Connectors: Provide connectors where noted, grounding-type, double wipe contacts, adjustable cord clamp, NEMA configuration to match mating plug where noted.
- E. General Use Switches:
1. Provide toggle switches in all spaces. Switches shall be 120/277 volts AC; quiet-type; color as selected by the Architect in finished and unfinished spaces; red for switches connected on emergency circuits; side wired; non-tracking case; undercut binder head screws; silver/cadmium alloy contacts with bronze spring arm; 20 ampere rating; SPST, DPST, 3 or 4-way, maintained or momentary contacts, or key operated as indicated. Key-operated switches shall be P&S #20AC1-KL Series, or approved equal.
 2. Provide toggle switches mounted in mullions suitable for side wiring; rated 15 amperes; single pole or three-way as indicated; quiet type; color to match other switches in same space type.
- F. Wallplates: Provide wallplates for single and combination wiring devices, of types, sizes, and ganging as required and cutouts as required for specified devices. Select wall

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plates of style which mate and match wiring devices to which attached. Unless stainless steel, color shall match associated wiring device except in unfinished spaces. All plates shall be by the same manufacturer unless specifically noted otherwise. Construct with metal screws for securing plates to devices; screw heads shall match finish of plates. Provide plates possessing the following additional construction features:

1. Steel plate, Type 302 stainless, 0.032" thick. Where installed on 2" wide mullions, wall plate shall be 1-3/4" wide.
 2. Weatherproof Duplex Receptacle Wallplates: Wallplates for weatherproof receptacles with the designation "WP" where indicated on drawings or where required by NEC shall be UL listed and NEMA 3R rated while outlet is in use or not used. The receptacle shall also be listed as weather-resistant type. The cover shall be single-gang or double-gang for two devices and shall not protrude over 4.5" from wall surface. Each cover shall be complete with required sealing gaskets, and stainless steel mounting screws. Covers shall capability to allow the passage of two flexible cords. Mount wallplates with long dimension vertical, except mount wallplates with long dimension horizontal where installed in brick. Wallplates shall be identified as "extra heavy duty" where required by NEC 406.9(B)(1). Wallplate cover units shall be as manufactured by Arlington Industries, Inc. or Taymac Corporation, or approved equal. Where mounted on mechanical equipment, provide "bubble" type weatherproof-while-in-use cover. Architect to select color finishes.
 3. Weatherproof Switch Wallplates: Wallplates for weatherproof switches with the designation "WP" where indicated on drawings or where required by NEC shall be single or double gang as required for number of switches indicated and shall not protrude over 5/8" from wall surface. Each cover shall be complete with required sealing gaskets and stainless steel mounting screws. Wallplates shall be as manufactured by Taymac Corporation. Architect to select color finishes.
- G. Foam Gaskets: Provide fire-retardant plastic foam sealer sheets for all wiring devices installed on the interior of exterior building walls. Install to form a seal between the wallplate and the wall. Sealer sheets shall be "Frost King" as manufactured by Thermwell Products Co., Inc., Paterson, NJ., or "Gasket 1" as manufactured by Pass & Seymour.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

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- B. Install wiring devices only in electrical boxes which are set in wall at depth not greater than permitted by NEC, and which are clean and free from excess building materials, dirt and debris.
- C. Install foam gaskets on all wiring devices installed on inside of exterior building walls.
- D. Install stainless steel wallplates in finished spaces.
- E. Install stainless steel wallplates in unfinished spaces.
- F. Install wall plates square and plumb with building lines.
- G. Mount all duplex receptacles vertically with mounting height as indicated in the Electrical Legend, unless noted otherwise. All receptacles shown at counter locations shall be mounted at height as indicated by an asterisk, unless noted otherwise. Only where there is a conflict with a mirror or medicine cabinet in Bathroom or Toilet counter locations the receptacle(s) shown shall be mounted horizontal with ground slot to the left. Center these receptacles between top of backsplash and bottom of mirror or cabinet.
- H. GFCI receptacles shall be readily accessible in locations required by NEC 210.8.
- I. Install wiring devices after wiring work is completed. Provide protective cover over each wiring device installed prior to painting operations.
- J. Install wallplates after painting work is completed and remove all protective covers.
- K. Apply sealant around all exterior mounted electrical devices (receptacles, photocells, switches, etc.) to provide weatherproofing and pest control; refer to Division 7 for joint sealers.

3.2 PROTECTION OF WALLPLATES AND RECEPTACLES

- A. Upon installation of wallplates and receptacles, make proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty or overloaded plugs.

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3.3 TESTING

- A. Prior to energizing circuitry, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing, test wiring devices to demonstrate compliance with requirements. Following energizing, a polarity test shall be made on all receptacles to determine that all receptacles have been properly connected and that grounding conductors are continuous throughout all outlets. This Contractor shall certify in writing to the Architect that the testing has been completed and all receptacles are wired properly.

END OF SECTION 262726

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing and installation of low voltage circuit protective devices or fuses. Extent of the work is indicated on drawings and as required by the NEC.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES

- A. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting-Capacity Class K Fuses". Provide overcurrent protective devices which are U.L. Listed and Labeled.
- B. NEC Compliance: Comply with 2014 NFPA-70 (NEC) as applicable to construction and installation of fusible devices.
- C. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
- D. ANSI Compliance: Comply with applicable requirements of ANSI C97.1 "Low-Voltage Cartridge Fuses 600 Volts or Less".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data on fuses used on this project, including specifications and electrical characteristics. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, and time-current trip characteristics curves.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Obtain all fuses used on the project from a single manufacturer. Provide fuses by Cooper Bussmann, Mersen or Littelfuse.

2.2 FUSES

- A. General: Except as otherwise indicated, provide NEMA FU 1 nonrenewable cartridge fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics as indicated or required to suit the equipment served, which comply with manufacturer's standard design and materials, and constructed in accordance with published product information and with industry standards and configurations.
- B. Extra Materials: For all types and ratings required, furnish additional fuses amounting to one unit for every 10 installed units, but not less than one set of 3 of each size and type. Provide a metal cabinet with lockable door to house all extra fuses, plus 25% spare capacity and fuse pullers for each size of fuse.
- C. Class RK5 Time-Delay Fuses: Provide UL Class RK5 time-delay fuses rated 250 or 600 volts as applicable, 60 Hz, with 200,000 RMS symmetrical interrupting current rating, Bussmann "Fusetron", FRN/FRS, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF FUSES

- A. Provide fuses in all fusible devices. Size of fuses shall be as noted or in accordance with fuse manufacturer's tables for back-up motor running protection. Install fuses so rating information is readable without removing fuses. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing; installation and connection of low voltage disconnect switches. Extent of the work is indicated on drawings and schedules and as required by the NEC.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to Division 26 for requirements of safety/disconnect switches used as service entrance equipment.

1.4 REFERENCES AND CODES

- A. Electrical Code Compliances: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to construction and installation of disconnect switches.
- B. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
- C. U.L. Compliance: Provide with requirements of UL 98, "Enclosed and Dead-Front Switches". Provide switches which are U.L. Listed and U.L. Labeled.
- D. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. No. KS 1, "Enclosed Switches", and 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)".

1.5 SUBMITTALS

- A. Submit manufacturer's descriptive literature and recommended installation instructions on enclosed switches.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide enclosed switches by one of the following:
 - 1. Square D /Schneider Electric Co.
 - 2. Cutler-Hammer, Inc./Eaton Corporation
 - 3. General Electric Co.
 - 4. Siemens Energy & Automation, Inc.

2.2 SAFETY SWITCHES

- A. Surface-mounted, general-duty or heavy-duty as applicable, horsepower-rated, fusible or non-fusible as indicated, safety switches with lugs suitable for copper or aluminum conductors and electro-silver plated current carrying parts, and with equipment ground bus with appropriate lugs. Fusible switches shall be provided with spring-reinforced fuse clips to reject all fuses except Class R current limiting type; fuse each phase. Switches shall have hinged door with defeatable interlock to prevent door from being opened in "ON" position; operating lever arranged for padlocking in the "OFF" position; arc quenchers; capacity and characteristics as required; non-teasable quick-make and quick-break mechanism; dead front; line side shield.
- B. Provide Service Entrance Rated safety/disconnect switches that are listed and labeled for service entrance applications where applicable.
- C. Provide a set of auxiliary contacts for disconnects serving VFD's, to send a "disable" signal to the VFD when the disconnect is opened.
- D. As a Contractor-option for equipment rated below 1/2 horsepower, provide horsepower-rated, fusible or non-fusible as indicated, toggle-type switches with provisions for padlocking in the "OFF" position, and with number of poles and voltage as indicated.

2.3 ENCLOSURES

- A. Listed for environmental conditions of installed locations, including:
 - 1. Indoor General Locations, except where noted below: NEMA Standard 250, Type 1 surface mounted, except where noted as flush.
 - 2. Indoor Damp or Wet Locations: NEMA Standard 250, Type 4, surface mounted.
 - 3. Outdoor Locations: NEMA Standard 250, Type 3R, surface mounted.

PART 3 - EXECUTION

3.1 INSTALLATION OF ENCLOSED SWITCHES

- A. Provide safety switches for all motor appliances for the project where indicated and required by the NEC.
- B. Coordinate enclosed switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- D. Install safety switches for use with motor-driven appliances, motors and controllers within sight of controller position, unless otherwise indicated, on a nearby wall, on the equipment served, or on an adequately constructed metallic framework. Where safety switches and maintenance receptacles are located on equipment served, the switches and/or maintenance receptacles shall be located where directed by the manufacturer of equipment or at a location that will not interfere with access panels or louvers.
- E. Provide labels indicating size and type of replacement fuses, glued to inside of door on all fusible switches.
- F. Apply sealant around all exterior mounted safety switches and enclosures to provide weatherproofing and pest control; refer to Division 7 for joint sealers.
- G. Unless noted otherwise on the drawings, all adjustable trip breakers shall have their long-time pick-up set to 100%. For breakers that have long-time pick-up set to less than 100%, provide label indicating what the setting is and that the wiring has been sized for this; also provide restricted access per NEC 240.6(C). A factory-authorized representative shall perform field adjustment of protective devices as required to place the equipment in final operating condition. Contractor shall notify Design Engineer once all breakers have been adjusted for field verification approval.
- H. Provide equipment identification name plates complying with Division 26 for identification for electrical systems.
- I. Provide field marking to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. Provide arc flash warning label made of high performance polyester, 3-1/2"H X 5"W, Brady Cat. No. 94913 or approved equal.

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3.2 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Prior to energization:
 - 1. Upon completion of installation, inspect interior and exterior of enclosed switches.
 - 2. Remove paint splatters and other spots inside and outside of the enclosed switches enclosure. Repair exposed surfaces to match original finish.
 - 3. Remove all wrenches, packing materials, and construction debris from inside the enclosed switches.
 - 4. Use vacuum (with non-metallic attachments) to collect loose dust, dirt, and particles from inside the enclosed switches enclosure and around the exterior of the enclosed switches enclosure.
 - 5. Do not use compressed air to assist in cleaning. Using compressed air is likely to spread contamination and damage insulation.
 - 6. Accumulated dirt, oil, or grease might require a solvent to be removed. Solvents used for cleaning of electrical equipment shall be selected carefully to ensure compatibility with materials being cleaned. Do not use any liquid cleaners, include spray cleaners, unless specified by the enclosed switches manufacturer, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of the insulation surfaces. Allow sufficient time for drying after cleaning enclosed switches with solvents. Wear the required PPE when working with potential hazardous solvents; refer to solvent material data sheets.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization:
 - 1. Prior to energization of enclosed switches, check all accessible connections to manufacturer's tightening torque specifications.
 - 2. Prior to energization of enclosed switches, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
 - 3. Prior to energization of enclosed switches, check for electrical continuity of circuits and for short-circuits.
- B. Certification: This Contractor shall certify in writing to the Architect that the above checks were made, including date of the checks and results.

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- C. Upon completion of installation, energize enclosed switches and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance, otherwise remove and replace with new units and retest.

END OF SECTION 262816

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SECTION 264313 - SURGE PROTECTIVE DEVICES (SPD)

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies the requirements of surge protection devices (SPD) for low voltage power systems. SPDs intended for Service Entrance equipment installation shall apply to IEEE C62.41, Category C3 waveforms. Extent of surge protective devices work is indicated by drawings and as specified herein.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to other Division 26 sections for conductors/cables, electrical raceways, boxes and fittings which are required in conjunction with installation of SPD units.

1.4 REFERENCES AND CODES

- A. Source Limitations: Obtain surge protective devices and accessories through one source from a single manufacturer.
- B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to authorities having jurisdiction and marked for the intended use.
- C. Comply with applicable requirements of the 2014 NFPA-70 (NEC), Article 285 pertaining to surge protective devices.
- D. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

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- E. Comply with IEEE C62.41, "IEEE Guide for surge voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449 4th Edition, "UL Standard for Surge Protective Devices."

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated, include physical characteristics, rated capacities, peak-surge current ratings per mode and per phase, operating characteristics, MCOV and any furnished specialties and accessories.
- B. Product Certificates: Certificate from manufacturer certifying products furnished comply with UL 1283 and UL 1449 listing and classification.
- C. Furnish independent certified test reports.
- D. Furnish operational and maintenance data.

1.6 SURGE PROTECTIVE DEVICE LOCATIONS

- A. Provide surge protective devices within or at the building service entrance panelboard. Also provide surge protective devices within or at secondary panelboards as indicated on the drawings or schedules.

1.7 MANUFACTURER QUALIFICATIONS

- A. All surge protective devices shall be manufactured by an ISO 9001-2001 certified company normally engaged in the design, development, and manufacture of such equipment. The certified company shall have been engaged in the commercial design and manufacture of SPD units for a minimum of ten (10) years. The manufacturer shall be represented by a firm that is located within 250 miles of the jobsite and has represented the manufacturer of the SPD units for a minimum of five (5) years.
- B. The surge protective device manufacturer shall provide unlimited free replacement of the entire SPD for all inoperable SPD units during the warranty period.

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1.8 WARRANTY

- A. The manufacturer of the SPD units shall provide a ten year limited warranty from the date of substantial completion against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation, and maintenance instructions. The warranty shall cover events that damaged the SPD, when they should not have damaged it. The warranty shall cover all parts, labor, and material to return the unit to serviceable condition. A factory trained local representative located within 250 miles of the jobsite shall provide on-site labor and system testing, if required, during the warranty period. The local representative shall own and operate test equipment capable of determining the clamping voltages of the systems provided on the project as well as ground measurement test equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Square D; Schneider Electric.
 - 2. Siemens Energy & Automation, Inc.
 - 3. General Electric Co.
 - 4. Cutler-Hammer, Inc.; Eaton Corporation.
 - 5. Surge Suppression, Inc.
 - 6. Advanced Protection Technologies, Inc.
 - 7. Current Technology, Inc.
 - 8. Liebert Corporation; a division of Emerson.
 - 9. United Power Corporation.

2.2 SURGE PROTECTIVE DEVICES

- A. Type 1 Surge Protection Device with the following features and accessories:
 - 1. 20kA nominal discharge current.
 - 2. 200kA short circuit current rating (SCCR).
 - 3. AC Sinewave True Tracking Filter with EMI/RFI Filtering.
 - 4. Phase Loss Monitoring with visual status indicators.
 - 5. Thermal protective MOVs.
 - 6. Audible Alarm, Silencing Switch and Form C Dry Contacts.

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7. 10 Protection Modes: (3) line-to-line (L-L), (3) line-to-neutral (L-N), (3) line-to-ground (L-G), and neutral-to-ground (N-G).
8. Surge Counter with reset button.
9. Fuses rated at 200-kA interrupting capacity.
10. Available in all common voltages and configurations.
11. Nominal Discharge Current and Measured Limiting Voltage Tests.
12. Connection Means: Permanently wired.
13. Standard NEMA 1 enclosure.
14. Integral disconnect.

B. Type 2 Surge Protective Device with the following features and accessories:

1. 20kA nominal discharge current.
2. 200kA short circuit current rating (SCCR).
3. AC Sine wave True Tracking Filter with EMI/RFI Filtering.
4. Phase Loss Monitoring with visual status indicators.
5. Thermal protective MOVs.
6. Audible Alarm, Silencing Switch and Form C Dry Contacts.
7. 10 Protection Modes: (3) line-to-line (L-L), (3) line-to-neutral (L-N), (3) line-to-ground (L-G), and neutral-to-ground (N-G).
8. Surge Counter with reset button.
9. Fuses rated at 200-kA interrupting capacity.
10. Nominal Discharge Current and Measured Limiting Voltage Tests.
11. Connection Means: Permanently wired.

C. Required Ratings:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, Main Entrance)	300 kA	150 kA
B	Exterior Locations, Distribution Panelboards, MCCs, Large Mechanical Equipment Panelboards, Panelboards Serving Exterior Equipment	160 kA	80 kA
A	Branch Locations (Panelboards, Busway)	120 kA	60 kA

D. 2017 NFPA 780 Table 4.20.4 Maximum Allowed Voltage Protection Rating (VPR) of Mode of Protection Provided for Different Power Distribution Systems to Which SPD Can Be Connected. The maximum VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700V	1200V	1800V

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L-L	1200V	1800V	4000V
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- E. The listed Maximum Continuous Operating Voltage (MCOV) must be a tested value (minimum 115% of nominal for 480Y/277V, and minimum 125% of nominal for 208Y/120V).

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Surge protective device units shall be installed in strict accordance with the manufacturer’s recommendations.
- B. Electrical Service, Distribution Panels and Panelboards:
 - 1. Provide SPD units at each building service entrance panelboard and at other primary or secondary panelboard locations as indicated on the drawings or schedules. When provided, the SPD units shall be located integrally or immediately adjacent to the panelboard being protected.
 - 2. Where SPD’s are indicated on the drawings as being integral to a piece of electrical gear, it shall be the contractor’s option to provide an external SPD instead, located as closely as possible to the gear being protected and in a NEMA enclosure appropriate for the installation environment. The contractor shall be fully responsible to ensure that there is sufficient wall space for the external SPD, as the external SPD is his option – change orders will not be approved due to the contractor not coordinating this.
 - 3. SPD units shall be served with a dedicated 3-pole 60-amp circuit breaker in the gear being served and (5) #6 AWG minimum stranded low impedance connection cable to the breaker, unless the manufacturer recommends differently. The conductors serving SPD units shall be twisted together to reduce the SPD system input impedance, and shall be kept at the minimum length. SPD units shall be installed in strict accordance with the manufacturer’s recommended practices and in compliance with NEC requirements. Measured impedance shall not be higher than 5 ohms on the ground for the service entrance SPD device. Where external, close nipple the SPD to the respective gear being protected.

3.2 GROUNDING CONNECTORS

- A. Connectors, splicers, and other fittings used to interconnect ground conductors, bond to equipment or grounding bars, shall be in accordance with NEC and U.L. requirements.
- B. All connectors and fittings shall be of the press crimp or compression set screw type.

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- C. Special treatment to fittings, lugs, or other connectors of dissimilar material shall be applied to prevent electro-galvanic action.

3.3 FINAL INSPECTION

- A. Each SPD installation shall be inspected by a licensed electrician to verify proper installation and operation in accordance with all applicable codes. Any deficiencies shall be corrected by the contractor. Provide written documentation of this inspection as part of the closeout documents/manual.

3.4 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect service entrance equipment or panelboards to their sources until surge protective devices are installed and connected.

END OF SECTION 264313

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SECTION 265000 - LIGHTING – INTERIOR, EXTERIOR AND EMERGENCY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of the interior, exterior and emergency luminaries, as well as battery-based emergency lighting equipment. Extent of the lighting systems work is indicated by drawings and schedules and as specified herein.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to other Division 26 sections for conductors / cables, raceways, electrical boxes and fittings required in connection with luminaires.

1.4 REFERENCES AND CODES

- A. Codes and Standards:
 - 1. Electrical Code Compliances: Comply with applicable requirements of the 2014 NFPA-70 (NEC) pertaining to installation and construction of lighting fixtures.
 - 2. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. Nos. LE 1 and LE 2 pertaining to lighting equipment, as well as NEMA std. Pub. Nos. 1B, 4, 5 and FA 1 pertaining to emergency lighting.
 - 3. UL Compliance: Comply with UL standards, including Stds. 486A and B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL-listed and labeled.
 - 4. All drivers shall comply with NEMA 410-2011 for inrush current.
 - 5. 0-10V dimming drivers shall comply with IEC 60929 as a current source.
- B. All drivers shall meet or exceed ANSI end-of-life requirements.
- C. In addition to the above requirements, LED fixtures shall comply with the latest applicable editions of the following:

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1. UL Standard 8750 “Light Emitting Diode Equipment for Use in Lighting Products”.
2. IES Standard LM-79 “Electrical and Photometric Measurements of Solid-State Lighting Products”.
3. IES Standard LM-80 “Measuring Lumen Maintenance of LED Light Sources”.
4. IES Standard TM-21 “Projecting Long Term Lumen Maintenance of LED Light Sources”.
5. ANSI C78.377 “Specifications for the Chromaticity of Solid State Lighting Products”.
6. NEMA SSL 1 “Electronic Drivers for LED Devices, Arrays or Systems”.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver lighting fixtures in factory-fabricated containers or wrappings which properly protect fixtures from damage.
- B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperature and humidity, laid flat and blocked off ground.
- C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data in booklet form with separate sheet for each luminaire type, assembled in "luminaire type" numerical or alphabetical order matching contract documents, with dimensional data, photometric data and accessories (including mounting brackets, etc.) for proposed luminaires.
- B. Shop Drawings: Submit luminaire shop drawings for all luminaires noted on luminaire schedule, indicating all special dimensional data, photometric data and accessories required for a complete installation. Driver data for each fixture shall be included.
- C. Maintenance Data: Submit manufacturer's technical product data for each luminaire and accessory, including a copy of the installation instructions for each type of luminaire installed. Include data in maintenance manual in accordance with requirements of Division 1.
- D. Also submit product and maintenance data for all emergency drivers.
- E. Extra Materials: For LED fixtures with replaceable LED modules/arrays, furnish one (1) spare of each type of module/array. Furnish one (1) spare driver of each type used. Label and deliver replacement stock as directed to Owner's storage space.

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1.7 WARRANTY

- A. All drivers (including emergency) shall have a minimum 5-year manufacturer's warranty.
- B. All LED luminaires shall have a limited minimum 5-year manufacturer's warranty for the light engine(s) or array(s) and driver.
- C. All other items in this section shall have a minimum 1-year manufacturer's warranty.

1.8 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to Division 1 for requirements in selecting products and requesting substitutions. ALL requests for substitutions, including value engineering, shall include catalog cuts for each luminaire type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Luminaires: Manufacturer's names and catalog numbers are indicated on the luminaire schedule on the drawings. Alternate luminaires will only be considered if submitted in accordance with the requirements of the supplementary instructions to bidders. Provide product data and catalog cuts or shop drawings as required above for each proposed alternate luminaire type.
- B. Individual Emergency Battery Drivers: Philips Bodine, Lithonia, Iota or approved equal.

2.2 LUMINAIRES

- A. General: Provide luminaires of sizes, types and ratings indicated, complete with but not limited to housings, reflectors, drivers, starters and wiring. Ship luminaires factory-assembled with parts required for a complete installation. Design luminaires with concealed hinges and catches, with metal parts grounded as a common unit and constructed so as to dampen driver-generated sounds. Provide thermal protection for recessed luminaires. Provide luminaires which are identified as suitable for installation in direct contact with thermal insulation where such installations occur.

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- B. Wiring: All wiring within luminaires shall have a minimum temperature rating of 90 degrees C and shall be sized in accordance with NEC.
- C. Lens: Provide nominal minimum 0.125" thick 7.8 oz./sq.ft. 100 percent virgin acrylic Type 12 pattern, plastic, UV stabilized lens for standard lensed 1'x4', 2'x4' and 2'x2' luminaires, unless noted otherwise.
- D. Pendants: All pendant mounting means, whether cable, chain, rod or stem, shall be provided in lengths as required to provide luminaire mounting heights as indicated.
- E. Additional requirements for LED luminaires:
 - 1. Color temperature shall be 4000K with minimum CRI of 80, unless indicated otherwise.
 - 2. LED's shall be binned within a maximum three-step MacAdam Ellipse to ensure color consistency amongst luminaires of the same type.
 - 3. Mercury-free, lead-free, RoHS compliant.
 - 4. Compliant with FCC 47 CFR Part 15 non-consumer RFI/EMI standards.
 - 5. Light output shall be measured using the absolute photometry method following IES LM-79 and LM-80 requirements and guidelines.
 - 6. Luminaires shall maintain at least 70% lumen output (L70) for a minimum of 50,000 hours.
 - 7. Lumen output shall not depreciate more than 20% after 20,000 hours of use.
 - 8. Thermally designed to not exceed the maximum junction temperature of the LED for the ambient temperature of the location in which the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found in the intended installation. Exterior luminaires shall be capable of operating in ambient temperatures of -20 deg. F to 122 deg F (-29 deg. C to 50 deg. C).
 - 9. Luminaires shall operate normally for input voltage fluctuations of plus or minus 10%.
 - 10. Maximum Total Harmonic Distortion (THD) of 10% at full input power and across specified voltage range.
 - 11. All connections to luminaires shall be reverse-polarity protected and provide high voltage protection in the event that connections are reversed or shorted during installation.
 - 12. The failure of one individual LED shall not affect the operation of the remaining LED's in the luminaire.

2.3 DRIVERS

- A. LED Drivers:
 - 1. Unless specifically indicated otherwise, shall be of the 0-10V dimming type down to 10% light level. The performance curves for the 0-10V control and the 0-10V

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drivers shall not both be logarithmic. Dimming shall occur down to the minimum level with no visible flicker or “popcorn effect”. “Popcorn effect” is when the luminaire is on a preset dimmed level, and the LED’s go to 100% prior to returning to the preset level when power is returned to the fixture.

2. Shall have rated life of minimum 50,000 hours.
3. Shall have minimum power factor of 0.9 and maximum crest factor of 1.5 at full input power and across specified voltage range.
4. Shall operate normally for input voltage fluctuations of plus or minus 10%.
5. Shall have maximum Total Harmonic Distortion (THD) of 10% at full input power and across specified voltage range.
6. Shall have polarized quick-disconnects for wiring connections for field maintenance.
7. Shall have built-in fuse protection, with all power supply outputs either fuse protected or Polymeric Positive Temperature Coefficient (PTC)-protected per Class 2 UL Listing.

- B. Voltages: Drivers shall be coordinated with circuit voltages as indicated on drawings. Some luminaire types may be connected on multiple voltages when utilized in different areas of the project.

2.4 INDIVIDUAL EMERGENCY BATTERY INVERTER UNITS

- A. Emergency lighting shall be provided by using a standard luminaire equipped with a UL listed, self-contained, modular, battery inverter unit complying with UL 924. The unit shall be mounted within the lighting fixture body or listed for installation on top of or remote from the fixture. The battery inverter unit shall consist of a high-temperature, maintenance-free, nickel cadmium battery, charger and electronic circuitry. The AC driver operation shall be delayed for approximately 3 seconds by the circuitry to prevent false tripping of AC driver. A solid-state charging LED indicator light to monitor the charger and battery and a single-pole test switch shall be provided and mounted such that the light and switch are visible and accessible within the fixture without entering the ceiling space. Where units are mounted outside the building envelope, provide cold-weather rated units.
- B. Emergency LED drivers shall have lumen outputs as indicated in the lighting fixture schedule.

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PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify ceiling construction in all areas prior to ordering luminaires to determine if luminaire type called for is correct to fit ceiling encountered. Notify Architect if any discrepancies are found.

3.2 INSTALLATION OF LUMINAIRES

- A. Coordinate the location of luminaires with other installations (i.e. diffusers, registers, grilles, speakers, sprinklers, finish ceiling height, structural components, fire rating, etc.) located in the same space.
- B. Locate ceiling-mounted luminaires where indicated on reflected ceiling plans, if reflected ceiling plans are included.
- C. Luminaires in mechanical and electrical rooms are shown for quantity and approximate location only. Coordinate final location with other work in the space to clear piping, ducts, valves and equipment. Some units may be required to be wall-mounted.
- D. Support all ceiling mounted luminaires that match the size of the layout of the ceiling grid from the building structural framing members or the ceiling framing system utilizing conduit stems, fixture studs, support clips, steel rods or bar hangers. If the ceiling framing system is used for support, install a minimum of two ceiling support system rods or wires for each luminaire (on diagonally opposite corners of the fixture). Locate not more than 6 inches from fixture corners.
- E. Fixtures of Sizes Less than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- F. Fasten luminaires securely to structural supports, and ensure that pendant luminaires are plumb, level and square with ceiling and walls unless indicated otherwise. Provide individually mounted pendant luminaires longer than 24" with twin stem hangers, unless noted otherwise; provide stem hanger with ball aligners and provisions for minimum 1" vertical adjustment. Mount continuous rows of luminaires with one additional stem hanger more than the quantity of luminaires in the row.
- G. Fasten recessed luminaires mounted in lay-in ceilings to the adjacent T-bars by approved fasteners or clips that are UL listed for the application.
- H. Submit design of hangers for review by Architect if method of fastening is other than indicated or specified herein.

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- I. Install recessed luminaires in plaster ceiling areas in rolled metal plaster frames.
- J. Where luminaires are provided with integral emergency power supplies, connect the battery charger on the indicated branch circuit on the line side of the local switch so that the battery/inverter circuit will remain energized when the lighting luminaire is extinguished.
- K. Support surface mounted luminaires greater than 24" in length at a point in addition to the outlet box fixture stud.
- L. Apply sealant around all exterior mounted light fixtures to provide weatherproofing and pest control; refer to Division 7 for joint sealants.

3.3 ADJUSTING AND CLEANING

- A. Clean luminaires of dirt, fingerprints, paint, dust and other debris upon completion of installation. Protect installed luminaires from damage during remainder of construction period.

3.4 FIELD QUALITY CONTROL

- A. At Date of Substantial Completion, for LED fixtures with built-in LED boards, replace boards or fixtures in which at least 5% of the individual LED's will not illuminate.
- B. Refer to sections of Division 1 for the replacement/restoration of lamps in interior luminaires, where used for temporary lighting prior to Date of Substantial Completion.

END OF SECTION 265000

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SECTION 271013 - INFRASTRUCTURE FOR BUILDING TELECOMMUNICATIONS CABLING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing and installation of an empty conduit system for the building telecommunications cabling system. The building telecommunications system includes, but is not limited to, telephone, cable television and data (computer) systems.
- B. The work of this section includes, but is not limited to, providing the main conduits from the service entrance point to the distribution rooms within the building, branch conduits, outlet boxes, and equipment panels and pull cords/strings.
- C. Unless otherwise noted, the Owner will contract directly with local installers for module frames, module jacks, faceplates, terminations, cables, and all head-end equipment including but not limited to racks, switches, routers, splitters, amplifiers, modulators, etc. required for a complete and operating telecommunications system.

1.2 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and Division 1 and Division 26 specification sections, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Refer to Division 26 sections for work including, but not limited to, electrical raceways, electrical boxes and fittings, electrical wiring devices, wallplates and cabinets required in conjunction with installation of the infrastructure for the telecommunications systems.

1.4 REFERENCES AND CODES

- A. 2014 NFPA-70--National Electrical Code
- B. ANSI/IEEE C-2--National Electrical Safety Code

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- C. OSHA Standards and Regulations
- D. Pertinent Local Codes and Standards

1.5 COORDINATION

- A. Coordinate work of this section with requirements of the local telephone, data and/or cable television service providers.

PART 2 - PRODUCTS

2.1 SYSTEM MATERIALS

- A. Provide wall outlets of standard 4-11/16" square (double-gang) by 2-1/8" deep outlet boxes, unless indicated otherwise on drawings, with 4" square by 3/4" mud ring or tile wall cover as applicable for single gang device. Face of mud ring or tile wall cover shall be flush with finished wall surface.
- B. Provide blank single gang wall plates of color and type of material to match adjacent wiring devices. The Owner will contract directly with a local contractor to remove blank fillers/plates as required and install desired telephone, television and/or data jacks, faceplates, equipment, connectors and cables.
- C. Provide equipment panels of 3/4" thick, FRT AC grade fire-retardant plywood of 4' x 8' size unless indicated otherwise on drawings. Paint with two coats of medium gray paint.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Follow all raceway requirements specified in Division 26.
 - 2. Label pull cords with outlet served.
 - 3. Apply sealant around all exterior mounted telecom outlets to provide weatherproofing and pest control; refer to Division 7 for joint sealants.

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4. Provide all conduit raceway runs of size and quantity as indicated on drawings and as specified below. Provide empty conduit raceways with nylon pull cord. The minimum size of any conduit not indicated shall be 1". All bends shall be long radius ells. ENT conduit may be used where concealed inside walls and above ceilings as specified in Division 26 and where permitted by codes.
5. Outlet locations indicated are for estimating purposes only. Coordinate final location with other installations and refer all conflicts to the Architect for resolution.

B. Administration/Common Areas:

1. Install one 1" conduit from each telecom outlet to the area above the accessible ceiling of room in which the outlet is located, or to the area above the nearest accessible corridor ceiling. Terminate conduits with bushing. If an accessible ceiling is not available, extend the conduits to the nearest telecommunication panel serving the respective floor. At equipment panels, terminate conduits with bushings at 0'-8" or 5'-10" above finished floors.
2. Where specifically noted to be "hard-piped" to an IT room, no more than 270 degrees of bends are allowed between pull boxes.

C. Feeder and Service:

1. Install empty service and feeder raceways as indicated on drawings. At equipment panels, terminate service and feeder raceways with bushings at 0'-8" and 7'-10" above finished floors.
2. Securely mount equipment panels to wall, level and plumb. Mount plywood equipment panels at 6'-6" AFF to top and mount data/communication cabinets at 6'-0" AFF to top, unless noted otherwise.

END OF SECTION 271013