

MILLCREEK COMMON

1353 EAST 3300 SOUTH, MILLCREEK, UTAH 84106

PROJECT MANUAL

CONTRACT DOCUMENTS / SPECIFICATIONS / DRAWINGS



A Millcreek City Project

January 15, 2021

PROCUREMENT AND CONTRACTING GROUP

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..... Geotechnical Report Ninyo & Moore

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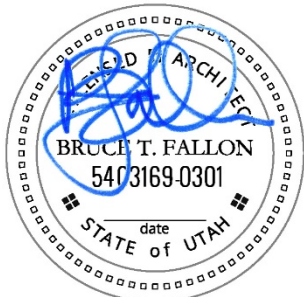
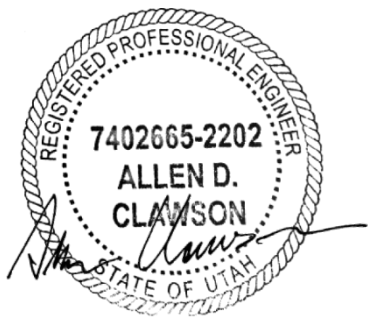
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Environmental Planning Group (EPG) Landscape Architect  EXP. 3/31/2022	WPA Architecture Architect 
WHW Engineering Mechanical Engineer 	BNA Consulting Electrical Engineer 
Cloward H2O Water Feature Design 	

SECTION 01 1000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work under separate contracts.
4. Access to site.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and Drawing conventions.

B. Related Requirements:

1. Section 01 5000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: Millcreek Common

1. Project Location: 1353 East 3300 South, Millcreek, Utah 84106

B. Owner: City of Millcreek.

1. Owner's Representative: Francis Xavier Lilly, Community Development Director, Millcreek City, (801) 214-2752.

C. Prime Consultant: Environmental Planning Group, LLC, 6949 S. High Tech Drive #100 Midvale, UT 84047.

1. Contact: Dave Harris, PLA, (801) 746-4457.
2. The Prime Consultant (Consultant) acting through duly authorized representatives, which may include delegation to subconsultants when appropriate. Where the specifications indicate a specific action to be by the Architect, Engineer, or other technical professional, the first order of coordination is to be through the Consultant for proper delegation.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. Construction of Millcreek Common Plaza and other Work indicated in the Contract Documents.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.4 CODES

- A. Conform to applicable requirements of the latest editions of the International Building Code, International Building Code Standards, International Mechanical Code, International Plumbing Code, National Electrical Code, National Fire Protection Association requirements, local ordinances, and UOSHA requirements applicable to this project, unless a higher standard is called for, without additional cost to the Owner.
- B. Comply with CABO/ANSI A117.1, American National Standard, "Accessible and Usable Buildings and Facilities" latest edition which is in force for the project location, for handicapped accessibility.

1.5 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 1. Driveways, Walkways, and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to adjacent business tenants and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

1.6 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Business tenants will occupy adjacent building(s) during entire construction period. Cooperate with tenants during construction operations to minimize conflicts and facilitate tenant's typical business usage of adjacent properties. Perform the Work so as not to interfere with tenant's day-to-day operations. Maintain existing exits unless otherwise indicated.

1.7 DUST CONTROL

- A. Provide continuous (7 days per week, 24 hours per day) fugitive dust control measures within the limits of the construction site, related sites and adjacent streets and roads. Dust control shall be provided for, but not be specifically limited to, the stabilization of unpaved roads, haul roads, access roads, spoil sites, borrow and material sources, excavations, embankments, stockpiles, and all other areas which become potential sources of dust as a result of construction activities.
- B. Dust control measures shall maintain compliance with applicable local air pollution control ordinances, and as directed by the Architect. Dust control measures shall include but not be limited to the following:
 1. Wetting of surfaces with water as appropriate.
 2. Minimizing surface disturbances.
- C. In order to control fugitive dust emissions, apply the following procedures and techniques:

1. Cover loads of materials, debris and waste materials taken from construction sites as needed to suppress dust during transit.
2. Water down or apply other approved dust control measures to the construction site, haul roads and public access roads as needed to suppress dust.
3. All mud and dirt shall be removed from vehicles prior to entering a paved or graveled area or road. Any mud or dirt that is carried out onto paved or graveled surfaces shall be removed from surfaces immediately and no less than daily.

1.8 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to the hours of 7:00 a.m. to 7:00 p.m., Monday through Friday, unless otherwise indicated or approved by the City.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by tenants or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 1. Notify Consultant not less than two days in advance of proposed utility interruptions.
 2. Obtain Consultant's written permission before proceeding with utility interruptions.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

1.10 INCIDENTAL WORK

- A. Work, materials or equipment that may reasonably be inferred from the Contract Documents as being required to produce the intended result shall be supplied by the Contractor at no additional cost to the Owner whether or not specifically called for in the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 1000

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 DEFINITIONS

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

1.3 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Execute accepted alternates under the same conditions as other work of the Contract.
- C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: PAVERS IN CHAMBERS AVE.
 - 1. Base Bid: Asphalt paving per civil and landscape LM plans in Chambers Avenue.
 - 2. Alternate: Add pavers per LM plans and civil in Chambers Avenue.

END OF SECTION 012300

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 MINOR CHANGES IN THE WORK

- A. Architect will issue through Construction Manager supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on form included in Project Manual.

1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Construction Manager will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Construction Manager are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Construction Manager.
 - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

1.4 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Construction Manager will issue a Change Order for signatures of Owner and Contractor on form included in Project Manual.

1.5 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Construction Manager may issue a Construction Change Directive on form included in Project Manual. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

1.6 WORK CHANGE DIRECTIVE

- A. Work Change Directive: Construction Manager may issue a Work Change Directive on EJCDC Document C-940 form included in Project Manual. Work Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Work Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.
 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Sections include the following:
 - 1. Section 01 2600 **“Contract Modification Procedures”** for administrative procedures for handling changes to the contract.
 - 2. Section 01 3300 **“Submittals”** for additional requirements for items to be furnished prior to first application for payment and with subsequent payment applications.

1.2 SCHEDULE OF VALUES

- A. Deliver the following documents to the Architect electronically in pdf format prior to submitting first application for payment. Document shall be submitted at earliest possible date to allow adequate time for review and comment but not less than 15 business days prior to first application for payment.
 - 1. Detailed Submittal schedule identifying all parts of the work.
 - 2. Detailed Procurement schedule linked to review and completion dates in both the Submittal and Construction schedules.
 - 3. Detailed Schedule of values.
 - 4. Detailed Project construction schedule.
- B. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor’s Construction Schedule:
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with Continuation Sheets.
 - b. Submittals Schedule
 - c. Sub-schedules: Where the work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.
- C. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one-line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the Schedule of Values.
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect’s project number.
 - d. Contractor’
 - 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. Description of Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value.
 - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in enough detail, as determined by the architect to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
 4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required by the Owner.
 6. Provide separate line items in the Schedule of Values for development of submittals, initial cost of materials, for each subsequent stage of completion such as below grade installation, above grade installation, controls programming, controls installation, controls, graphics, and controls materials, etc; and for total installed value of that part of the Work.
 7. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
 8. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change

1.3 APPLICATIONS FOR PAYMENT

- A. General: Each Application for Payment shall be consistent with the previous applications and payments as certified by Architect and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.
- D. Application Preparation: Complete every entry form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedule if revision were made.
 2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Transmittal: Submit 4 signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt with 24 hours. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
1. Submit partial waivers on each item for amount requested, before deduction for retainage, on each item.
 2. When an application shows completion of an item, submit final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Waiver Delays: Submit each Application for Payment with Contractor's waiver of mechanic's lien for construction period covered by the application.
 - a. Submit final Application for Payment with or proceeded by final waivers from every entity involved with performance of the Work covered by the application that is lawfully entitled to a lien.
 5. Waiver Forms: Submit waivers of lien on forms, executed in a manner
- G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Products list (preliminary if not final).
 5. Sustainable design action plans, including preliminary project materials cost data.
 6. Schedule of unit prices.
 7. Submittal schedule (preliminary if not final).
 8. List of Contractor's staff assignments.
 9. List of Contractor's principal consultants.
 10. Copies of building permits.
 11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 12. Initial progress report.
 13. Report of preconstruction conference.
 14. Certificates of insurance and insurance policies.
 15. Performance and payment bonds.
 16. Data needed to acquire Owner's insurance.
- H. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- I. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706.
 5. AIA Document G706A.
 6. Evidence that claims have been settled.
 7. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 8. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Project meetings.
- B. Related Sections:
 - 1. Section 01 3300 "Submittals" for procedures for coordinating electronic submittals.
 - 2. Section 01 7300 "Execution Requirements" for procedures of coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 07 7700 "Closeout Procedures" for coordinating Contract closeout.

1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Memoranda: 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 attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

- C. **Administrative Procedures:** Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
- D. **Administrative Software Requirements:** Submittal all project related information (i.e. Submittals, RFI's, ASI's, Addenda, Construction documents, Project logs, Field reports, and Meeting minutes) electronically using the Architect's File Transfer Site. Architect will provide access information to the General Contractor at the pre-construction meeting or as appropriate to the schedule of the project.
1. Employ a PDF review software system such as Bluebeam (www.bluebeam.com) or another similar system for producing, formatting, and marking-up project related documents. Construction Manager or General Contractor shall review documents and add their stamp and comments directly to the PDF prior to posting for the Design team to review.
 2. Provide to the Architect and Owner, an electronic archive of all data at the end of project via DVD(s) for final project records.
- E. **Keep a printed Record of all Construction Documents** including all clarifications, RFI's, and approved changes to the Contract on site.
- F. **Conservation:** Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1.4 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 23 Section "Basic Mechanical Materials and Methods" and Division 26 Section "Basic Electrical Materials and Methods" for specific Coordination Drawing requirements for mechanical and electrical installations.
- B. **Staff Names:** Within 5 business 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. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

C. **Submittal Log:** See section 'Submittals' for electronic delivery and record keeping.

1.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and other supervisory personnel as required for proper performance of the Work.
1. Include special personnel required for coordination of operations with other contractors.
 2. Construction superintendent shall be on the Project site whenever Sub-contractors are working on the project.

1.6 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 1. 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 and long lead items.
 - d. Designation of key personnel and their duties.
 - e. Procedures for processing field decisions and Charge Orders.
 - f. Procedures for processing Applications for Payment.
 - g. Distribution of the Contract Documents.
 - h. Submittal procedures.
 - i. Preparation of Record Documents.
 - j. Responsibility for temporary facilities and controls.
 - k. Parking availability.
 - l. Office, work, and storage areas.
 - m. Equipment deliveries and priorities.
 - n. First aid.
 - o. Security.

- p. Progress cleaning.
 - q. Working hours.
- 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
 - 1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 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) Change Orders.
 - 14) 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.

1.7 REQUESTS FOR INFORMATION (RFI)

- A. **Procedure:** Immediately on discovery of the need for interpretation of Contract Document, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.

1. RFIs shall originate with Construction Manager or General Contractor. RFIs submitted by entities other than Construction Manager or General Contractor will be returned with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. **Content of the RFI:** Include a detailed, legible description of item needing interpretation and the following:
1. Project name.
 2. Date.
 3. Name of Contractor.
 4. Name of Architect and Owner.
 5. RFI number, numbered sequentially.
 6. Specification Section number and title and related paragraphs, as appropriate.
 7. Drawing number and detail references, as appropriate.
 8. Field dimensions and conditions, as appropriate.
 9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contractor Time or the Contract Sum, Contractor shall state impact in the RFI.
 10. Contractor's signature.
 11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
 - a. Supplementary drawings prepared by Contractor shall include dimensions, thickness, structural grid references, and details of affected materials, assemblies, and attachments.
- C. **Hard-Copy RFIs:** Use the form supplied by the Architect or the Owner.
1. Identify each page of attachments with the RFI number and sequential page number.
 2. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. **Electronic RFIs:**
1. RFIs shall be processed and delivered electronically through Architect's internal database system with sequential numbers.
- E. **Architect's Action:** Architect will review each RFI, determine action required, and return it. Allow seven (7) working days for Architect's response for each RFI. RFI's received after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Request for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Request for adjustments in the Contract Time or Contract Sum.
 - e. Requests for interpretation of Architect's actions on submittals.
 - f. Incomplete RFIs or RFI with numerous errors.
 2. Architect's action may include a request for additional information, in which case Architect's Time for response will start again.
 3. Architect's action on RFI that may result a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."

- a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Owner in writing within 10 calendar days of receipt of the RFI response.
- F. On receipt of Architect's and Owner's action, update the RFI log and immediately distribute the RFI response to the affected parties. Review response and notify Architect and Owner within seven calendar days if Contractor disagrees with response.
- G. **RFI Log:** Prepare, maintain, and submit a tabular log of RFIs organized by RFI number. Submit log monthly.
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. Name and address of Architect and Owner.
 - 4. RFI number including RFIs that were dropped and not submitted.
 - 5. RFI description.
 - 6. Date the RFI was submitted.
 - 7. Date Architect's and Owner's response was received.
 - 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 - 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 3100

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's and Construction Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's and Construction Manager's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect.
4. Name of Construction Manager.
5. Name of Contractor.
6. Name of firm or entity that prepared submittal.
7. Names of subcontractor, manufacturer, and supplier.
8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
9. Category and type of submittal.
10. Submittal purpose and description.
11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
12. Drawing number and detail references, as appropriate.

13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
16. Remarks.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect and Construction Manager on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Paper Submittals:

1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect and Construction Manager.
3. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect, through Construction Manager, will return two copies.
4. Informational Submittals: Submit two paper copies of each submittal unless otherwise indicated. Architect and Construction Manager will not return copies.
5. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using sample form included in Project Manual transmittal form.

E. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

F. Submittals for Web-Based Project Software: Prepare submittals as PDF files, or other format indicated by Project software website.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
2. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
3. Paper: Prepare submittals in paper form, and deliver to Architect.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Construction Manager's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Construction Manager will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Resubmittal Review: Allow 15 days for review of each resubmittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's and Construction Manager's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
 - a. Two opaque (bond) copies of each submittal. Architect, through Construction Manager, will return one copy.
 - b. Three opaque copies of each submittal. Architect and Construction Manager will retain two copies; remainder will be returned.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
 4. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
 6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

7. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect, through Construction Manager, will return submittal with options selected.
8. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three sets of Samples. Architect and Construction Manager will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least **[three] <Insert number>** sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
 1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit **[digitally signed PDF file] [and] [three] <Insert number>** paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and Construction Manager.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 1. Architect and Construction Manager will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S AND CONSTRUCTION MANAGER'S REVIEW

- A. Action Submittals: Architect and Construction Manager will review each submittal, indicate corrections or revisions required, and return it.
 1. PDF Submittals: Architect and Construction Manager will indicate, via markup on each submittal, the appropriate action.
 2. Paper Submittals: Architect and Construction Manager will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
 3. Submittals by Web-Based Project Software: Architect and Construction Manager will indicate, on Project software website, the appropriate action.
- B. Informational Submittals: Architect and Construction Manager will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect and Construction Manager will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and Construction Manager.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Architect and Construction Manager will discard submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 2. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of **[five]** **<Insert number>** previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Laboratory Mockups: Full-size physical assemblies constructed and tested at testing facility to verify performance characteristics.

2. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as part of permanent construction, consisting of multiple products, assemblies, and subassemblies.
 3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
 - F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
 - G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
 - H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
 - I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
 - J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect or Construction Manager.

1.3 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1.4 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS

- A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Statement on condition of substrates and their acceptability for installation of product.
 2. Statement that products at Project site comply with requirements.
 3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 5. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Statement that equipment complies with requirements.
 2. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 3. Other required items indicated in individual Specification Sections.

1.8 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - d. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
 - 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and through Construction Manager, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. **Mockups:** Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups of size indicated.
 - 2. Build mockups in location indicated or, if not indicated, as directed by Architect or Construction Manager.
 - 3. Notify Architect and Construction Manager seven days in advance of dates and times when mockups will be constructed.
 - 4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
 - 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 6. Obtain Architect's and Construction Manager's approval of mockups before starting corresponding work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 - 7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 8. Demolish and remove mockups when directed unless otherwise indicated.
- L. **Laboratory Mockups:** Comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.9 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 6. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.10 SPECIAL TESTS AND INSPECTIONS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

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

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.2 USE CHARGES

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

1.3 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- D. Moisture-and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.
- E. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system isolation schematic drawing.

3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines.

1.5 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, Construction Manager, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot square tack and marker boards.
 3. Drinking water and private toilet.
 4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 5. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

2.2 EQUIPMENT

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

- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction.
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

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

3.3 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 - 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
- G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service overhead unless otherwise indicated.
- H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.4 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 - 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 - 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings.
 - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Provide temporary parking areas for construction personnel.

- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
 - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 - 3. Maintain and touch up signs so they are legible at all times.
- G. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- K. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
 - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.
- L. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."
- D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings [requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- E. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- F. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- G. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- H. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- I. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
- J. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- K. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

- L. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- M. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- N. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - 2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 3. Provide walk-off mats at each entrance through temporary partition.
- O. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
 - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
 - 3. Indicate methods to be used to avoid trapping water in finished work.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 - 1. Protect porous materials from water damage.
 - 2. Protect stored and installed material from flowing or standing water.
 - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 - 4. Remove standing water from decks.

5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard and replace stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for requests for substitutions.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect will notify Contractor through Construction Manager of approval or

rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Form of Architect's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
- b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.4 QUALITY ASSURANCE

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

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

- B. Delivery and Handling:

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

- C. Storage:

- 1. Store products to allow for inspection and measurement of quantity or counting of units.
- 2. Store materials in a manner that will not endanger Project structure.
- 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
- 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
- 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
- 6. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on

product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."
 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 - a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: ..."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
 - a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: ..."
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 - a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: ..."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: ..."
7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 2. Evidence that proposed product provides specified warranty.
 3. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 4. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for limits on use of Project site.
 - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.

1.2 INFORMATIONAL SUBMITTALS

- A. Certificates: Submit certificate signed by **[land surveyor]** **[professional engineer]** certifying that location and elevation of improvements comply with requirements.
- B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- C. Certified Surveys: Submit **[two]** **<Insert number>** copies signed by **[land surveyor]** **[professional engineer]**.
- D. Final Property Survey: Submit **[10]** **<Insert number>** copies showing the Work performed and record survey data.

1.3 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut

- and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services; and other utilities.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where

indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect and Construction Manager promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 2. Establish limits on use of Project site.
 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major element as the Work progresses.
 6. Notify Architect and Construction Manager when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect and Construction Manager.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
 - 1. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Remove and replace damaged, defective, or non-conforming Work.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to **[minimize] [prevent]** interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 - 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- 3.8 STARTING AND ADJUSTING
- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 3. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.4 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

- B. Submittals Prior to Substantial Completion: Complete the following a minimum of [10] <Insert number> days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Construction Manager. Label with manufacturer's name and model number.
 5. Submit testing, adjusting, and balancing records.
 6. Submit sustainable design submittals not previously submitted.
 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of [10] <Insert number> days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 6. Advise Owner of changeover in utility services.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements.
 10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1.5 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1.6 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Architect, through Construction Manager, will return annotated file.
 - b. PDF electronic file. Architect, through Construction Manager, will return annotated file.
 - c. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).
 - d. Three paper copies. Architect, through Construction Manager, will return two copies.

1.7 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
1. Submit on digital media acceptable to Architect by uploading to web-based project software site or by email to Architect.

D. Warranties in Paper Form:

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. 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.
 - c. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - d. Sweep concrete floors broom clean in unoccupied spaces.
 - e. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - f. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - g. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - h. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - i. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

- D. Construction Waste Disposal: Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations, before requesting inspection for determination of Substantial Completion.
- B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

END OF SECTION 017700

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Requirements:
 - 1. Section 017300 "Execution" for final property survey.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit **one** set(s) of marked-up record prints.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints.
 - 2) Submit record digital data files.
 - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints.
 - c. Final Submittal:
 - 1) Submit record digital data files.
- B. Record Specifications: Submit one annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

1.3 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Format: DWG, Microsoft Windows operating system.

3. Format: Annotated PDF electronic file with comment function enabled.
4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
5. Refer instances of uncertainty to Architect through Construction Manager for resolution.
6. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.

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

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect and Construction Manager.
 - e. Name of Contractor.

1.4 RECORD SPECIFICATIONS

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

1.5 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- C. Format: Submit record Product Data as annotated PDF electronic file scanned PDF electronic file(s) of marked-up paper copy of Product Data.
 - 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

1.6 MAINTENANCE OF RECORD DOCUMENTS

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

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017839

SECTION 02 4119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected site elements.
2. Salvage of existing items to be reused or recycled.

1.2 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
1. When discovered, carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 PREINSTALLATION MEETINGS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- B. Schedule of selective demolition activities with starting and ending dates for each activity.
- C. Predemolition photographs or video.

1.5 CLOSEOUT SUBMITTALS

- A. Inventory of items that have been removed and salvaged.

1.6 FIELD CONDITIONS

- A. Tenants will occupy portions of buildings immediately adjacent to selective demolition area. Conduct selective demolition so Tenant's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Before selective demolition, owner will evaluate existing site and select items to be salvaged and removed.
- C. Notify Consultant of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Consultant and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 1. Maintain fire-protection facilities in service during selective demolition operations.
- G. Arrange selective demolition schedule so as not to interfere with Tenant's operations.

1.7 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Inventory and record the condition of items to be removed and salvaged.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off utilities with utility companies.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to adjacent buildings.

3.3 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - 4. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
 - 1. Clean salvaged items.
 - 2. Store items in a secure area until delivery to Owner.
 - 3. Transport items to Owner's storage area off-site designated by Owner.

- 4. Protect items from damage during transport and storage.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

3.5 CLEANING

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn demolished materials.
- C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 4119

SECTION 03 10 00 - CONCRETE FORMING AND ACCESSORIES

1.1 SUMMARY

- A. Section Includes:
 - 1. Form-facing material for cast-in-place concrete.
 - 2. Shoring, bracing, and anchoring.

1.2 ACTION SUBMITTALS

- A. Product Data: For each of the following:
 - 1. Exposed surface form-facing material.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
 - 1. Provide continuous, true, and smooth concrete surfaces.
 - 2. Furnish in largest practicable sizes to minimize number of joints.
 - 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete, and as follows:
 - a. Plywood, metal, or other approved panel materials.
 - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1.
 - 1) APA HDO (high-density overlay).
 - 2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
 - 3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
 - 4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.
- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
 - 1. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 - 2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.3 INSTALLATION OF FORMWORK

- A. Comply with ACI 301 (ACI 301M).
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M) and to comply with the Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete" for as-cast finishes and Section 03 33 00 "Architectural Concrete".

- C. Limit concrete surface irregularities as follows:
 - 1. Surface Finish-1.0: ACI 117 Class D, 1 inch (25 mm).
 - 2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch (6 mm).
 - 3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch (3.0 mm).
- D. Construct forms tight enough to prevent loss of concrete mortar.
 - 1. Minimize joints.
 - 2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
 - 1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 - 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
 - 1. Provide and secure units to support screed strips.
 - 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
 - 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 - 2. Locate temporary openings in forms at inconspicuous locations.
- I. Do not chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches (305 mm).
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
 - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 3. Place joints perpendicular to main reinforcement.
 - 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
 - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 6. Space vertical joints in walls at 10'-0" maximum spacing.
 - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
 - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
 - 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

2.4 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
 - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
 - 5. Clean embedded items immediately prior to concrete placement.

END OF SECTION 03 10 00

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SECTION 03 20 00 - CONCRETE REINFORCING

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel reinforcement bars.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of steel reinforcement.
 - 2. Bar supports.
- B. Shop Drawings: Comply with ACI SP-066:
 - 1. Include placing drawings that detail fabrication, bending, and placement.
 - 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
 - 1. Location of construction joints is subject to approval of the Architect.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
 - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.

2.2 FABRICATING REINFORCEMENT

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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Do not cut or puncture vapor retarder.
 - 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 2. Do not tack weld crossing reinforcing bars.

- C. Preserve clearance between bars of not less than 1 inch (25 mm), not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318 (ACI 318M).
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches (610 mm), whichever is greater.
 - 2. Stagger splices in accordance with ACI 318 (ACI 318M).
 - 3. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
 - 4. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
 - 5. Lace overlaps with wire.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement.
 - 2. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117 (ACI 117M).

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: As outlined in Statement of Special Inspections.

END OF SECTION 03 20 00

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
 - 1. Section 31 20 00 "Earth Moving" for drainage fill under slabs-on-grade.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.3 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.
- C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
- D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.6 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1.
 - 1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M).

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301 (ACI 301M).
 - 2. ACI 117 (ACI 117M).

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.4 CONCRETE MATERIALS

- A. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150/C 150M, Type II.
 - 2. Fly Ash: ASTM C 618.
- B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Air-Entraining Admixture: ASTM C 260/C 260M.
- D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- E. Water: ASTM C 94 and potable.

2.5 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape. Subject to compliance with requirements, available manufacturers offering products that may be incorporated in to the Work include, but are not limited to the following:
 - 1. Stego Industries, LLC
 - 2. W.R. Meadows, Inc.

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.8 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).
- B. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Normal-Weight Concrete:
 - 1. Minimum Compressive Strength: As indicated at 28 days.
 - 2. Maximum W/C Ratio: 0.50 for 3000 psi; 0.45 for 4000 psi.
 - 3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
 - 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
 - 5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.10 FABRICATING REINFORCEMENT

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

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M).

3.2 EMBEDDED ITEM INSTALLATION

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

3.3 VAPOR-RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT INSTALLATION

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

3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

3.6 WATERSTOP INSTALLATION

- A. Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions.

3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture

of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
 1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to surfaces to receive trowel finish.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 3/16 inch (4.8 mm).
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.
 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.10 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 (ACI 301M) for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - 3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.11 CONCRETE SURFACE REPAIRS

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

3.12 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 03 30 00

SECTION 03 30 00 – CAST-IN-PLACE EXPOSED ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cast-in-place architectural concrete, including form facings, reinforcement accessories, concrete materials, concrete mixtures, concrete placement, and concrete finishes.
 - 2. Requirements in Section 03 30 00 "Cast-in-Place Concrete" apply to this Section.

1.2 DEFINITIONS

- A. Aggregate Exposure: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.
- B. Cast-in-Place Architectural Concrete: Concrete that is exposed to view, is designated as architectural concrete, and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
- C. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- D. designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.
- E. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each of the following:
 - 1. Form-facing panels.
 - 2. Form joint tape.
 - 3. Form joint sealant.
 - 4. Wood sealer.
 - 5. Form-release agent.
 - 6. Surface retarder.
 - 7. Form ties.
 - 8. Bar supports.
 - 9. Portland cement.
 - 10. Fly ash.
 - 11. Slag cement.
 - 12. Blended hydraulic cement.
 - 13. Aggregates.
 - 14. Admixtures:
 - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
- B. Samples: For each of the following materials:
 - 1. Form-facing panels.
 - 2. Form ties.
 - 3. Form liners, 12-by-12-inch (305-by-305-mm) Sample, indicating texture.
 - 4. Exposed aggregates.
 - 5. Chamfers and rustications.
- C. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Curing process.

D. Placement Schedule: Submit before start of placement operations.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each of the following:
1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
- B. Material Test Reports: For the following, by a qualified testing agency:
1. Portland cement.
 2. Fly ash.
 3. Slag cement.
 4. Blended hydraulic cement.
- C. Research Reports: For concrete admixtures in accordance with ICC AC198.
- D. Preconstruction Test Reports: For each mix design.

1.6 QUALITY ASSURANCE

- A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Installer Qualifications: An experienced cast-in-place architectural concrete installer, as evidenced by not less than five consecutive years' experience, specializing in installing cast-in-place architectural concrete 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.
1. Provide written evidence of qualifications and experience.
 2. Include locations, descriptions, and photographs of completed projects, including name of architect, substantiating the quality of the installer's experience.
- C. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches (1200 by 1200 by 150 mm) minimum, to demonstrate the expected range of finish, color, and texture variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
 2. Demonstrate methods of curing, aggregate exposure, wood sealers, and coatings, as applicable.
 3. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
 4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 5. Demolish and remove field sample panels when directed.
- D. Mockups: Before casting architectural concrete, build mockups, using the same procedures, equipment, materials, finishing procedures, and curing procedures that will be used for producing architectural concrete, to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, color, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 2. Build mockups of typical wall of cast-in-place architectural concrete as shown on Drawings, including vertical and horizontal rustication joints, and any sculptured features.
 3. Construct mockups to include at least two lifts having heights equal to those anticipated for construction.

4. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
5. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces.
6. In presence of Architect, demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
7. Obtain Architect's approval of mockups before casting architectural concrete.
8. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.
 1. Include the following information in each test report:
 - a. Admixture dosage rates.
 - b. Slump.
 - c. Air content.
 - d. Seven-day compressive strength.
 - e. 28-day compressive strength.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 (ACI 301M) unless modified by requirements in the Contract Documents.

2.2 FORM-FACING MATERIALS

- A. Comply with Section 03 10 00 "Concrete Forming and Accessories" for formwork and other form-facing material requirements, and as specified in this Section.
- B. Form-Facing Panels for Exposed Finishes:
 1. Steel- and glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 2. Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces.
- C. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths.
- D. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch (6 mm) thick.
- E. Form Joint Sealant: Elastomeric sealant complying with ASTM C920, Type M or Type S, Grade NS, that adheres to form joint substrates, does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.
- F. Wood Sealer: Penetrating, clear, polyurethane wood sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood and does not stain, does not adversely affect concrete surfaces, and does not impair subsequent treatments and finishes of concrete surfaces.
- G. Form-Release Agent: Commercially formulated, colorless form-release agent that does not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments and finishes of architectural concrete surfaces.
 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Surface Retarder: Water-soluble chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed architectural concrete surface to depth of aggregate exposure specified.

2.3 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place.
 - 1. Manufacture bar supports in accordance with CRSI's "Manual of Standard Practice."

2.4 CURING MATERIALS

- A. Comply with Section 03 30 000 "Cast-in-Place Concrete."

2.5 CONCRETE MIXING

- A. Architectural Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.
 - 1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
 - 2. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
 - 3. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
 - 4. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with Section 03 10 00 "Concrete Forming and Accessories" for formwork, embedded items, and shoring and reshoring, and as specified in this Section.
- B. Limit deflection of form-facing panels to not exceed ACI 301 (ACI 301M) requirements.
- C. Limit cast-in-place architectural concrete surface irregularities, as follows:
 - 1. Surface Finish-1.0: ACI 117 (ACI 117M) Class D, 1 inch (25 mm).
 - 2. Surface Finish-2.0: ACI 117 (ACI 117M) Class B, 1/4 inch (6 mm).
 - 3. Surface Finish-3.0: ACI 117 (ACI 117M) Class A, 1/8 inch (3.0 mm).
- D. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ACI 117M).
- E. Chamfer exterior corners and edges of cast-in-place architectural concrete.
- F. Coat contact surfaces of wood rustications and chamfer strips with wood sealer before placing reinforcement, anchoring devices, and embedded items.
- G. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.
- H. Coat contact surfaces of forms with surface retarder, in accordance with manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.

3.2 INSTALLATION OF REINFORCEMENT AND ACCESSORIES

- A. Comply with Section 03 20 00 "Concrete Reinforcing" for fabricating and installing steel reinforcement and accessories.

3.3 JOINTS

- A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.

3.4 CONCRETE PLACEMENT

- A. Comply with Section 03 30 00 "Cast-in-Place Concrete."

3.5 FINISHING FORMED SURFACES

- A. Comply with Section 03 30 00 "Cast-in-Place Concrete."
- B. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.

3.6 CONCRETE CURING

- A. Comply with Section 03 30 00 "Cast-in-Place Concrete" using identical curing procedures to that used for mockups.

3.7 REPAIR

- A. Comply with ACI 301 (ACI 301M).
- B. Repair damaged finished surfaces of cast-in-place architectural concrete when repairing is approved by Architect.
- C. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
- D. Remove and replace cast-in-place architectural concrete that cannot be repaired to Architect's approval.

3.8 FIELD QUALITY CONTROL

- A. Comply with Section 03 30 00 "Cast-in-Place Concrete."

3.9 CLEANING

- A. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
- B. Wash and rinse surfaces in accordance with concrete finish applicator's written instructions.
 - 1. Protect other Work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

3.10 PROTECTION

- A. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
- B. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

3.11 FINAL ACCEPTANCE

- A. Final acceptance of completed architectural concrete Work will be determined by Architect.

END OF SECTION 03 33 00

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SECTION 04 22 000 – CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete masonry units.
 - 2. Clay face brick.

1.2 ALLOWANCES

- A. Face brick is part of the Face Brick Allowance.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type and color of exposed masonry unit and colored mortar.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of product. For masonry units, include data on material properties and material test reports substantiating compliance with requirements.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
 - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
- B. CMUs: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1500 psi.
 - 2. Density Classification: Normal weight.

2.3 BRICK

- A. Regional Materials: Brick shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
 - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 - 2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- C. Clay Face Brick: Facing brick complying with ASTM C 216.
 - 1. Grade: MW or SW.
 - 2. Type: FBS.
 - 3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 8250 psi (56.88 MPa).
 - 4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67.
 - 5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 - 6. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing according to ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
 - 7. Size (Actual Dimensions): 3-9/16 inches (90 mm) wide by 2-1/4 inches (57 mm) high by 11-9/16 inches (294 mm) long.

2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91/C 91M.
- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- F. Aggregate for Mortar: ASTM C 144.
 - 1. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 - 2. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C 404.

- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
- J. Water: Potable.

2.5 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
- B. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.
- C. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
 - 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 - 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
 - 1. Wire: Fabricate from 3/16-inch- (4.76-mm-) diameter, hot-dip galvanized-steel wire.

2.6 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with Section 07 62 00 "Sheet Metal Flashing and Trim" and as follows:
 - 1. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
 - 2. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
 - 3. Fabricate metal expansion-joint strips from copper to shapes indicated.
- B. Flexible Flashing: Use one of the following unless otherwise indicated:
 - 1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.76 mm). 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. Advanced Building Products, Inc.
 - b. Carlisle Coatings and Products, Inc.
 - c. W.R. Meadows, Inc.
 - 2. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.
 - 3. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637/D 4637M, 0.040 inch (1.02 mm) thick.
 - a. Carlisle Coatings and Products, Inc.
 - b. Firestone Specialty Products
- C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.7 MASONRY CLEANERS

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

2.8 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
 - 3. For exterior masonry, use portland cement-lime or masonry cement mortar.
 - 4. For reinforced masonry, use portland cement-lime or masonry cement mortar.
 - 5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
 - 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
 - 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
- C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- E. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and CMUs as follows:
 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid masonry units and hollow brick with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Lay structural clay tile as follows:
 1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
 2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
 3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch- (6- to 10-mm-) thick joints.
- D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
 3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
- C. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
 2. Space weep holes 24 inches (600 mm) o.c. unless otherwise indicated.
 3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
- D. Place cavity drainage material in cavities and airspace behind veneers to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- E. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.6 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches.

3.7 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.
1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
- F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

- G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.8 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.9 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. 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.
 - 3. Protect adjacent surfaces from contact with cleaner.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.10 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 22 00

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SECTION 04 70 00 – MANUFACTURED MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manufactured masonry veneer.
 - 2. Board Form and Rectangle veneer
 - 3. Manufactured trim.
 - 4. Application materials.

1.2 REFERENCES

- A. American National Standards Institute (ANSI A118.4) Prepackaged Latex Portland Cement Mortar.
- B. ASTM International (ASTM):
 - 1. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 2. ASTM C67 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
 - 3. ASTM C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - 4. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 5. ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes.
 - 6. ASTM C270 Standard Specification for Mortar for Unit Masonry.
 - 7. ASTM C482 Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement.
 - 8. ASTM C567 Standard Test Method for Determining Density of Structural Lightweight Concrete.
 - 9. ASTM C847 Standard Specification for Metal Lath.
 - 10. ASTM C932 Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering.
 - 11. ASTM C979 Standard Specification for Pigments for Integrally Colored Concrete.
 - 12. ASTM C1032 Standard Specification for Woven Wire Plaster Base.
 - 13. ASTM C1059 Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete.
 - 14. ASTM D226 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Water-proofing.
- C. Building Materials Evaluation Commission.
- D. International Code Council (ICC):
 - 1. ICC ES AC 51 Acceptance Criteria for Precast Stone Veneer.
 - 2. ICC ESR-3685
 - 3. UBC Standard No. 14-1, Kraft Waterproof Building Paper.

1.3 SUBMITTALS

- A. Refer to Section 01 33 00 - Submittal Procedures:
 - 1. Product Data: Manufactured masonry and application materials including weather resistive barriers.
 - 2. Samples: Panel containing full-size samples of specified manufactured masonry showing full range of colors and textures complete with specified mortar. Size of masonry sample is approx. 16 by 24 inches (400 by 600 mm).
 - 3. Quality Assurance Submittals:
 - a. Installer Qualifications: Proof of installer qualifications 5 years minimum.
 - b. installation Instructions: Manufacturer's instructions for veneer and other materials.
- B. Closeout Submittals - Submit the following items:
 - 1. Maintenance Instructions.
 - 2. Special Warranties.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Mason with 5 years of experience installing manufactured stone veneer.
- B. Certifications:
 - 1. ICC ESR-3685 in accordance with AC51.
 - 2. CE Declaration of Conformity
- C. Field Samples: Prepare sample at location selected by Architect showing representative sample of installed product including penetration and termination details, corner detail, and mortar color and tooling.
 - 1. Reference Section 01 45 00 - Quality Control.
 - 2. Minimum size: 4 by 4 feet (1200 by 1200 mm)
 - 3. Approved field samples may remain as part of completed Work.
 - 4. Obtain Architect's approval.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Reference Section 01 66 00–Product Storage and Handling Requirements.
- B. Follow manufacturer's instructions.

1.6 PROJECT/SITE CONDITIONS

- A. Cold weather installations: Maintain materials and ambient temperature at minimum 40 degrees F (4 degrees C) prior to, during, and for 48 hours following installation.
- B. Hot weather installations: Mist water on the scratch coated surface and the backs of the masonry veneer for installations that exceed 90 degrees (32 degrees C).

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard 50-year warranty coverage against defects in materials when installed in accordance with manufacturer's installation instructions.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: Creative Mines, LLC, 6102 Avenida Encinas, Suite M, Carlsbad, CA 92011, Tel: 800.453.7040, E-Mail: create@creativemines.us, Website: www.creativemines.us
 - 1. Manufacturer's Distributor: Brick Design Co. (Midvale, Utah), LKL Associates (West Jordan and Orem, Utah)
- B. Substitutions: Equal as approved by Architect prior to bidding

2.2 MANUFACTURED MASONRY VENEER UNITS

- A. Craft Stone Veneer:
 - 1. Product: Craft Orchard Limestone veneer.
 - 2. Profile: Manufacturer's standard, including matching corner pieces.
- B. Veneer Unit Properties;
 - 1. Compressive Strength: ASTM C 192 and ASTM C 39, Greater than 1,800 psi (12.4 MPa).
 - 2. Shear Bond strength to Mortar: ASTM C 482, 50 psi (345 kPa).
 - 3. Water Absorption: UBC Standard 15-5, Less than 22 percent.
 - 4. Freeze-Thaw Test: ASTM C 67, 50 Cycles, no disintegration and less than 3 percent weight loss.
 - 5. Fire Resistance: ASTM E119 or UL 263.
 - 6. Maximum Veneer Unit Weight: 15 lbs/sf (73 kg/gm²)

2.3 ACCESSORY MATERIALS

- A. Metal Lath: ASTM C847; 18 gauge woven wire or self-furring, galvanized, 2.5 lb/sy or 3.4 lb/sy metal lath.
- B. Fasteners:
 - 1. Wood Studs: Minimum 3/4" (19 mm) crown galvanized staples or minimum 1/8" (3.1 mm) shank diameter galvanized nails that penetrate the stud minimum 3/4" (19 mm).
- C. Mortar and Grout: Standard Type S or Type N Mortar is suitable for grouted veneer. For tight fit, drystacked applications use a Polymer Modified Mortar.
 - 1. Comply with ASTM C 270 for Type S or Type N Mortars.
 - 2. Mortar Color: ASTM C 979 mineral oxide pigments.
 - 3. Water: Potable
 - 4. Prepackaged Polymer Modified Mortars: ANSI A118.4 or ANSI A118.15 or equivalent.
 - 5. Color: As selected by Architect from full product line.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrate.
- B. Coordinate corrective actions of unsatisfactory substrates.
- C. Commencement of work is acceptance of condition of substrate.

3.2 PREPARATIONS

- A. Protection: Protect surrounding work from damage by work in this area.
- B. Surface Preparation: Installations directly over masonry/concrete substrates ensure they do not have residual coatings present which may affect bonding of mortar to the substrate and correct problem according to manufacturer.

3.3 INSTALLATION

- A. Weather Resistive Barrier: Install in accordance with manufacturer's installation instructions.
- B. Control Joints: Size in accordance with Section 07 92 00 – Joint Sealant for sealant performance, but in no case larger than adjacent mortar joints in exposed stone units.
- C. Expansion Joints: Provide where indicated on Drawings or as recommended by manufacturer.
- D. Manufactured Masonry Veneer: Install veneer in accordance with manufacturer's installation instructions.
- E. Board Form and Rectangle Veneer: Install Board Form and Rectangle veneer in accordance with manufacturer's installation instructions.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Representatives: Provide two (2) periodic site visits as requested by Architect.

3.5 CLEANING & SEALING

- A. Cleaning: Reference Section 01 74 00 - Cleaning and Waste Management.
- B. Remove excess mortar and smears using a soft bristle brush within 1 to 2 hours of installation.
- C. Clean the masonry veneer in accordance with manufacturer's installation instructions. Do not use acid cleaners.
- D. For high freeze-thaw regions, use a silane or siloxane based breathable masonry sealer.

END OF SECTION 04 70 00

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SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Structural steel.
 - 2. Grout.
- B. Related Requirements:
 - 1. Section 05 12 13 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992.
- B. Channels, Angles: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B structural tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; Type 1, hardened carbon-steel washers; all with plain finish.

2.3 PRIMER

- A. Primer: Comply with Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

2.4 GROUT

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

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

- B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

2.6 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 - 2. Surfaces to be field welded.
 - 3. Surfaces of high-strength bolted, slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 5. Galvanized surfaces.
 - 6. Surfaces enclosed in interior construction.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
 - 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

3.3 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

END OF SECTION 05 12 00

SECTION 05 12 13 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

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. Architecturally exposed structural steel (AESS).
 - 2. Section 05 12 00 "Structural Steel Framing" requirements that also apply to AESS.

1.3 DEFINITIONS

- A. AESS: Architecturally exposed structural steel.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication of AESS components.
 - 1. Identify AESS category for each steel member and connection, including transitions between AESS categories and between AESS and non-AESS.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172) and is experienced in fabricating AESS similar to that indicated on this Project.
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program, is designated an AISC-Certified Erector, Category ACSE, and is experienced in erecting AESS similar to that indicated on this Project.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or SSPC-QP 3.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Use special care in handling AESS to prevent twisting, warping, nicking, and other damage during fabrication, delivery, and erection. Store materials to permit easy access for inspection and identification. Keep AESS members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect AESS members and packaged materials from corrosion and deterioration.
 - 1. Do not store AESS materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 FIELD CONDITIONS

- A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of ANSI/AISC 303, Sections 1 through 9 and as modified in Section 10, "Architecturally Exposed Structural Steel."

2.2 FILLER

- A. Polyester filler intended for use in repairing dents in automobile bodies.

2.3 PRIMER

- A. Steel Primer:
 - 1. Comply with Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- B. Galvanized Steel Primer: MPI#134.
 - 1. Etching Cleaner: MPI#25, for galvanized steel.
 - 2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.4 FABRICATION

- A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.
 - 1. Use special care handling and fabricating AESS before and after shop painting to minimize damage to shop finish.
- B. Category AESS 1:
 - 1. Comply with overall profile dimensions of AWS D1.1/D1.1M for welded built-up members. Keep appearance and quality of welds consistent. Maintain true alignment of members without warp exceeding specified tolerances.
 - 2. Prepare surfaces according to Part 2 "Shop Priming" Article and SSPC-SP 6 (WAB)/NACE WAB-3.
 - 3. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surfaces and eased edges.
 - 4. Make intermittent welds appear continuous, using filler or additional welding.
 - 5. Seal weld open ends of hollow structural sections with 3/8-inch (9.5-mm) closure plates.
 - 6. Limit butt and plug weld projections to 1/16 inch (1.6 mm).
 - 7. Install bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
 - 8. Remove weld spatter, slivers, and similar surface discontinuities.
 - 9. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.
 - 10. Grind tack welds smooth unless incorporated into final welds.
 - 11. Remove backing and runoff tabs, and grind welds smooth.
 - 12. Contour and blend welds and weld transitions between members, removing splatter exposed to view.
 - 13. Fill surface imperfections with filler and sand smooth to achieve surface quality approved by Architect.
 - 14. Minimize weld show-through and distortion on the opposite side of exposed connections by grinding to a smooth profile aligned with adjacent material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS 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.

3.3 ERECTION

- A. Take special care during erection to avoid marking or distorting the AESS and to minimize damage to shop painting. Set AESS accurately in locations and to elevations indicated and according to ANSI/AISC 303 and ANSI/AISC 360.

1. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Take care to avoid any blemishes, holes, or unsightly surfaces resulting from the use or removal of temporary elements.
2. Grind tack welds smooth.
3. Remove backing and runoff tabs, and grind welds smooth.
4. Orient bolt heads on the same side of each connection and maintain orientation consistently from one connection to another.
5. Conceal fabrication and erection markings from view in the completed structure.

3.4 REPAIR

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and touchup galvanizing to comply with ASTM A780/A780M.

3.5 FIELD QUALITY CONTROL

- A. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

END OF SECTION 05 12 13

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SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof deck.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. Evaluation reports.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 ROOF DECK

- A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
 - 1. Galvanized-Steel Sheet: ASTM A 653/A 653M, zinc coating.
 - 2. Deck Profile: As indicated.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- C. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- D. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- E. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- F. Mechanical fasteners may be used in lieu of welding to fasten deck. Provide submittal for review and approval.
- G. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- H. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

3.3 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

END OF SECTION 05 31 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Miscellaneous steel trim.
 - 2. Downspout guards.
 - 3. Loose bearing and leveling plates.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Loose steel lintels.
 - 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 - 3. Steel weld plates and angles for casting into concrete.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Fasteners.
 - 2. Shop primers.
 - 3. Shrinkage-resisting grout.
 - 4. Pipe guards.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum, stainless steel or nickel silver.
- B. Post-Installed Anchors: Torque-controlled expansion anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 09 91 13 "Exterior Painting," and Section 09 91 23 "Interior Painting."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
- B. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and

weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.6 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
 - 1. Provide mitered and welded units at corners.
 - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize and prime shelf angles located in exterior walls.
- D. Prime shelf angles located in exterior walls with zinc-rich primer.
- E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.7 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.
- D. Prime exterior miscellaneous steel trim with zinc-rich primer.

2.8 DOWNSPOUT GUARDS

- A. Fabricate downspout guards from 3/8-inch- (9.5-mm-) thick by 12-inch- (300-mm-) wide, steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch (50-mm) clearance between pipe and pipe guard. Drill each end for two 3/4-inch (19-mm) anchor bolts.
- B. Galvanize and prime steel downspout guards.
- C. Prime steel downspout guards with zinc-rich primer.

2.9 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Galvanize and prime loose steel lintels located in exterior walls.
- C. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.10 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.11 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.

2.12 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with primers specified in Section 09 91 13 "Exterior Painting" unless zinc-rich primer is indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Items Indicated to Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
 - 5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

- C. Anchor shelf angles securely to existing construction with expansion anchors, anchor bolts or through bolts.

3.3 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 50 00

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SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel railings.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Handrail brackets.
 - 3. Shop primer.
 - 4. Intermediate coats and topcoats.
 - 5. Bituminous paint.
 - 6. Nonshrink, nonmetallic grout.
 - 7. Anchoring cement.
 - 8. Metal finishes.
 - 9. Paint products.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Samples: For each type of exposed finish.
- E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For delegated-design professional engineer.
- B. Welding certificates.
- C. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.

- c. Uniform and concentrated loads need not be assumed to act concurrently.
- 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 - 1. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Tubing: ASTM A500/A500M (cold formed) or ASTM A513/A513M, Type 5.
- C. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 - 1. Provide galvanized finish for exterior installations and where indicated.
- D. Plates, Shapes, and Bars: ASTM A36/A36M.

2.4 FASTENERS

- A. Fastener Materials:
 - 1. Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941 (ASTM F1941M), Class Fe/Zn 5 for zinc coating.
 - 2. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
- B. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
 - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.5 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Cast nickel-silver, center of handrail 2-1/2 inches (63.5 mm) from wall.
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
 - 1. For stainless steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Shop Primers: Provide primers that comply with Section 09 91 13 "Exterior Painting".
- F. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

- G. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- H. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- I. Intermediate Coats and Topcoats: Provide products that comply with Section 09 91 13 "Exterior Painting."
- J. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- K. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
- L. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.
- M. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- N. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- B. Form work true to line and level with accurate angles and surfaces.
- C. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay
- D. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- E. Form changes in direction as follows:
 - 1. By bending.
- F. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- G. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- H. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

- J. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
- K. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows.
 - 1. Comply with SSPC-SP 16.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below:
 - 1. Exterior Railings: SSPC-SP 6/NACE No. 3.
 - 2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
 - 3. Railings Indicated To Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
 - 4. Other Railings: SSPC-SP 3.
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 1. Shop prime uncoated railings with universal shop primer unless zinc-rich primer is indicated.
 - 2. Do not apply primer to galvanized surfaces.
- G. Shop-Painted Finish: Comply with Section 09 91 13 "Exterior Painting."
 - 1. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 ANCHORING POSTS

- A. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
- C. Install removable railing sections, where indicated on Drawing, in slip-fit stainless steel sockets cast in concrete.

3.3 ATTACHING RAILINGS

- A. Attach handrails to walls with wall brackets. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface.
- B. Secure wall brackets to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.
 - 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
- C. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

3.4 CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 52 13

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SECTION 05 73 00 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel and iron decorative railings.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's product lines of decorative metal railings assembled from standard components.
 - 2. Handrail brackets.
 - 3. Shop primer.
 - 4. Intermediate coats and topcoats.
 - 5. Bituminous paint.
 - 6. Nonshrink, nonmetallic grout.
 - 7. Anchoring cement.
 - 8. Metal finishes.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
- C. Shop Drawings: Include plans, elevations, sections, and attachment details.
- D. Samples: For each type of exposed finish required.
- E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For delegated-design professional engineer.
- B. Welding certificates.
- C. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- D. Preconstruction test reports.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made by Owner. Retesting of products that fail to meet specified requirements shall be done at Contractor's expense.
 - 1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
 - 2. Test railings in accordance with ASTM E894 and ASTM E935.
 - 3. Notify Architect seven days in advance of the dates and times when laboratory mockups will be tested.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.3 STEEL AND IRON DECORATIVE RAILINGS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Tubing: ASTM A500/A500M (cold formed) or ASTM A513/A513M, Type 5.
- C. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.
- D. Plates, Shapes, and Bars: ASTM A36/A36M.
- E. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.4 FASTENERS

- A. Fastener Materials:
 - 1. Hot-Dip Galvanized-Steel Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
 - 2. Dissimilar Metal Railing Components: Type 304 stainless steel fasteners.
- B. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593 and nuts, ASTM F594.

2.5 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Cast stainless steel, center of handrail 2-1/2 inches (63.5 mm) from wall.
- B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Shop Primers: Provide primers that comply with Section 09 91 13 "Exterior Painting."
- F. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- G. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- H. Shop Primer for Galvanized Steel: Water-based galvanized metal primer complying with MPI#134.
- I. Intermediate Coats and Topcoats: Provide products that comply with Section 09 91 13 "Exterior Painting."
- J. Epoxy Intermediate Coat: Complying with MPI#77 and compatible with primer and topcoat.
- K. Polyurethane Topcoat: Complying with MPI#72 and compatible with undercoat.
- L. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- M. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Connections: Fabricate railings with welded or mechanical connections unless otherwise indicated.
- C. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.
- D. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings.
- E. Form changes in direction as follows:
 - 1. As detailed.
 - 2. By bending.
- F. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- G. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- H. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other Work unless otherwise indicated.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize steel and iron railings, including hardware, after fabrication.
 - 2. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
 - 3. Comply with ASTM A123/A123M for hot-dip galvanized railings.
 - 4. Comply with ASTM A153/A153M for hot-dip galvanized hardware.

5. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows:
 1. Comply with SSPC-SP 16.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below:
 1. Exterior Railings: SSPC-SP 6/NACE No. 3.
 2. Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.
 3. Railings Indicated To Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.
 4. Other Railings: SSPC-SP 7/NACE No. 4.
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 1. Fit exposed connections together to form tight, hairline joints.
 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 4. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3 m).
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

3.2 ANCHORING POSTS

- A. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
- C. Install removable railing sections, where indicated on Drawings, in slip-fit metal sockets cast in concrete.

3.3 ATTACHING RAILINGS

- A. Attach handrails to walls with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface.
- B. Secure wall brackets and railing end flanges to building construction as follows:
 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 2. For hollow masonry anchorage, use toggle bolts.

3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.

C. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

3.4 CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 73 00

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SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Framing with dimension lumber.
 - 2. Framing with engineered wood products.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Wood blocking, cants, and nailers.
 - 5. Wood furring.
 - 6. Wood sleepers.
 - 7. Plywood backing panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.

1.3 INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent
- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium

- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
 - 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 - 4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 - 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat items indicated on Drawings, and the following:
 - 1. Concealed blocking.
 - 2. Framing for non-load-bearing partitions.
 - 3. Framing for non-load-bearing exterior walls.
 - 4. Roof construction.
 - 5. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

- A. Non-Load-Bearing Interior Partitions: Standard, Stud, or No. 3 grade.
 - 1. Application: Interior partitions not indicated as load bearing.
 - 2. Species:
 - a. Western woods; WCLIB or WWPA.
- B. Framing Other Than Non-Load-Bearing Partitions: No. 2 Except as noted in plans.
 - 1. Application: Framing other than interior partitions not indicated as load bearing.
 - 2. Species:
 - a. Douglas fir-larch; WCLIB or WWPA.
- C. Exposed Framing: Hand-select material for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 - 1. Species and Grade: As indicated above for load-bearing construction of same type.

2.5 ENGINEERED WOOD PRODUCTS

- A. Engineered Wood Products, General: Products shall contain no urea formaldehyde.

- B. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.
 - 1. Extreme Fiber Stress in Bending, Edgewise: 2600 psi.
 - 2. Modulus of Elasticity, Edgewise: 1,900,000 psi .
- C. Wood I-Joists: Prefabricated units, I-shaped in cross section, made with solid or structural composite lumber flanges and wood-based structural panel webs, let into and bonded to flanges. Comply with material requirements of and with structural capacities established and monitored according to ASTM D 5055.
 - 1. Comply with APA PRI-400. Factory mark I-joists with APA-EWS trademark indicating nominal joist depth, joist class, span ratings, mill identification, and compliance with APA-EWS standard.
- D. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research or evaluation report for I-joists.
 - 1. Comply with APA PRR-401, rim board grade. Factory mark rim boards with APA-EWS trademark indicating thickness, grade, and compliance with APA-EWS standard.

2.6 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
- B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.

2.7 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, C-C Plugged, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.
 - 1. Plywood shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, as appropriate for the substrate.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

- C. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- D. Install shear wall panels to comply with manufacturer's written instructions.
- E. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- F. Do not splice structural members between supports unless otherwise indicated.
- G. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- I. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.

3.2 PROTECTION

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

END OF SECTION 06 10 00

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Framing with dimension lumber.
 - 2. Rooftop equipment bases and support curbs.
 - 3. Wood blocking and nailers.
 - 4. Wood furring and grounds.
 - 5. Wood sleepers.
 - 6. Plywood backing panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For installation adhesives, indicating VOC content.

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Preservative-treated wood.
 - 2. Fire-retardant-treated wood.
 - 3. Power-driven fasteners.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat the following items:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.

3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 1. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 2. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841. For enclosed roof framing, framing in attic spaces, and where high-temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
- C. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- D. Application: Treat the following items:
 1. Concealed blocking.
 2. Roof framing and blocking.
 3. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
 4. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

- A. Non-Load-Bearing Interior Partitions: Construction, Stud, or No. 3 grade of any species.
- B. Other Framing: Construction, Stud, or No. 3 grade of any of the following species:
 1. Hem-fir (north); NLGA.
 2. Southern pine; SPIB.
 3. Douglas fir-larch; WCLIB or WWPA.
 4. Spruce-pine-fir; NLGA.
 5. Douglas fir-south; WWPA.
 6. Hem-fir; WCLIB or WWPA.
 7. Douglas fir-larch (north); NLGA.
 8. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

2.5 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
 3. Rooftop equipment bases and support curbs.
 4. Cants.
 5. Furring.
 6. Grounds.
 7. Utility shelving.
- B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.
- C. Concealed Boards: 15 percent maximum moisture content of any of the following species and grades:
 1. Mixed southern pine or southern pine, No. 3 grade; SPIB.
 2. Eastern softwoods, No. 3 Common grade; NELMA.
 3. Northern species, No. 3 Common grade; NLGA.
 4. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.

2.6 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Screws for Fastening to Metal Framing: ASTM C1002 or ASTM C954, length as recommended by screw manufacturer for material being fastened.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.
 - 1. Verify adhesives have a VOC content of 70 g/L or less.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. ICC-ES evaluation report for fastener.

3.2 PROTECTION

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

END OF SECTION 06 10 53

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SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof sheathing.
 - 3. Composite nail base insulated roof sheathing.
 - 4. Subflooring.
 - 5. Underlayment.
 - 6. Sheathing joint and penetration treatment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WALL SHEATHING

- A. Plywood Sheathing: Exterior, Structural I sheathing.
- B. Oriented-Strand-Board Sheathing: Exposure 1, Structural I.
- C. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.
 - 1. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.

2.3 ROOF SHEATHING

- A. Plywood Sheathing: Exterior, Structural I sheathing.
- B. Oriented-Strand-Board Sheathing: Exposure 1, Structural I sheathing.

2.4 FLOOR SHEATHING

- A. Plywood Sheathing: Exterior, Structural I sheathing.
- B. Oriented-Strand-Board Sheathing: Exposure 1, Structural I sheathing.

2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.

2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
 3. ICC-ES evaluation report for fastener.
- D. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
1. Floor Sheathing:
 - a. Glue and nail to wood framing.
 - b. Space panels 1/8 inch (3 mm) apart at edges and ends.
 2. Wall and Roof Sheathing:
 - a. Nail to wood framing.
 - b. Space panels 1/8 inch (3 mm) apart at edges and ends.
 - c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.3 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
1. Fasten gypsum sheathing to wood framing with nails or screws.
 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 3. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
 4. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 06 16 00

SECTION 06 18 00 - GLUED-LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes framing using structural glued-laminated timber.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An AITC- or APA-EWS-licensed firm.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with provisions in AITC 111.
- B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

PART 2 - PRODUCTS

2.1 STRUCTURAL GLUED-LAMINATED TIMBER

- A. General: Provide structural glued-laminated timber that complies with AITC A190.1 and AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.
 - 1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
 - 2. Provide structural glued-laminated timber made with wet-use adhesive complying with AITC A190.1.
 - 3. Adhesive shall not contain urea-formaldehyde resins.
 - 4. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Species and Grades for Structural Glued-Laminated Timber: Douglas fir-larch.
- C. Species and Grades for Beams:
 - 1. Species and Beam Stress Classification: Douglas fir-larch, 24F-1.8E.
- D. Appearance Grade: Framing, complying with AITC 110.

2.2 FABRICATION

- A. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.
- B. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.
- C. End-Cut Sealing: Immediately after end cutting each member to final length, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.

- D. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
 - 1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.
- B. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.
- C. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing.
 - 1. Predrill for fasteners using timber connectors as templates.
 - 2. Finish exposed surfaces to remove planing or surfacing marks.
 - 3. Coat cross cuts with end sealer.

3.2 ADJUSTING

- A. Repair damaged surfaces after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect.

3.3 PROTECTION

- A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.
 - 1. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 06 18 00

SECTION 06 20 13 - EXTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Exterior wood trim.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
- B. Sustainable Design Submittals:
 - 1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
- C. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Certified Wood: Verify the following wood products are made from certified wood tracked through a chain-of-custody process. Provide certified wood documentation from sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "Technical Barriers to Trade."
 - 1. Exterior trim.
- B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of inspection agency, indicating grade, species, moisture content at time of surfacing, and mill.
 - 2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.

2.2 EXTERIOR TRIM

- A. Lumber Trim for Unfinished Applications:
 - 1. Species and Grade: IPE (Brazilian Walnut) Clear All Heartwood.
 - 2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
 - 3. Finger Jointing: Not allowed.
 - 4. Face Surface: Surfaced (smooth).

2.3 MISCELLANEOUS MATERIALS

- A. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
 - 1. For face-fastening siding, provide ringed-shank siding nails or hot-dip galvanized-steel siding nails.
 - 2. For ipe, provide hot-dip galvanized-steel fasteners.
- B. Sealants: Latex, complying with ASTM C834 Type OP, Grade NF and applicable requirements in Section 07 92 00 "Joint Sealants," and recommended by sealant and substrate manufacturers for intended application.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

- B. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed.
 - 1. Cut to required lengths and prime ends.
 - 2. Comply with requirements in Section 09 91 13 "Exterior Painting."

3.2 INSTALLATION, GENERAL

- A. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials.
 - 1. Use concealed shims where necessary for alignment.
 - 2. Scribe and cut exterior finish carpentry to fit adjoining work.
 - 3. Refinish and seal cuts as recommended by manufacturer.
 - 4. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
 - 5. Coordinate exterior finish carpentry with materials and systems in or adjacent to it.
 - 6. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

3.3 INSTALLATION OF STANDING AND RUNNING TRIM

- A. Install flat-grain lumber with bark side exposed to weather.
- B. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long, except where necessary.
 - 1. Use scarf joints for end-to-end joints.
 - 2. Stagger end joints in adjacent and related members.
- C. Fit exterior joints to exclude water.
 - 1. Cope at returns and miter at corners to produce tight-fitting joints, with full-surface contact throughout length of joint.
 - 2. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
- D. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.

END OF SECTION 06 20 13

SECTION 06 26 00 – CHARRED WOOD SIDING & PANELING

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Rough Carpentry: Section 06 10 00
- B. Finish Carpentry: Section 06 20 00
- C. Sheetmetal Flashing & Trim: Section 07 62 00
- D. Caulking & Sealing: Section 07 92 00
- E. Field Painting & Finishing: Section 09 90 00

1.2 SAMPLES

- A. In accordance with Section 01 33 00, submit 2 Samples of specified Siding. and Paneling.

1.3 PRODUCT DELIVERY

- A. Do not deliver Products to Jobsite until notified by General Contractor that Project is conditioned and prepared to handle and store Products without damage or discoloration.

1.4 PRODUCT STORAGE & HANDLING

- A. Protect against damage and discoloration.
- B. Do not expose Siding & Paneling to direct sunlight or rain.
- C. Separate Siding & Paneling bundles to promote air-circulation.
- D. Prior to installation, acclimate Siding & Paneling at Project Site for at least 14 days.

1.5 ILLUMINATION

- A. Perform no Work under less than 30 ft. candles of light measured 3 ft. above adjacent Ground Surface.

1.6 TEMPERATURE

- A. Maintain 50°F minimum in interior spaces where Materials are located.

PART 2 - PRODUCTS

2.1 FURRING

- A. Material: Lumber
- B. Species: Douglas Fir
- C. Grain: Mixed
- D. WWPA Grade: Construction
- E. Surface Texture: Smooth
- F. Size: See Drawings

2.2 SIDING & PANELING

- A. Manufacturer: Nakamoto Forestry; 4110 SE Hawthorne Blvd.; Suite 190; Portland, OR 97214-5246, USA; (503) 512-6780.
- B. Brand: Gendai (*Modern once-brushed smooth*)
- C. Species: Japanese Cypress (*Cryptomeria Japonica*)
- D. Grade: Select

- E. Exposed Face Grain: Flat
- F. Required ASTM E-84 Fire-resistance Rating Class: A
- G. Maximum Moisture Content at time of installation: 14%
- H. Shape: Square Edge
- I. Nominal (Actual) Overall Size:
 - 1. Square Edge Boards: 1x6 (9/16 x 5-11/16) inches
- J. Length: 12 ft.

2.3 SIDING & PANELING TRIM

- A. Material: Lumber
- B. Species: Cypress
- C. Grain: Mixed
- D. WWSA Grade: B & btr.
- E. Maximum Moisture Content at time of installation: 12%
- F. Surface Texture: Resawn with Fine Band Saw
- G. Minimum Lengths:
 - 1. Opening & Standing Trim: 1-piece single-length
 - 2. Running Trim: Joints no closer than 12 ft. apart.

2.4 FASTENERS

- A. Type: Nails
- B. Manufacturing Standard: Fed. Spec. FF-N-105B
- C. Material: Stainless Steel
- D. Type: Ring or Spiral Shank with Blunt or Medium-diamond Point
- E. Minimum Length: 2 inches

2.5 FACTORY-FINISH

- A. For Exterior Work:
 - 1. Material: 2 coats Penetrating Oil Stain
 - 2. Stain Color: Satin Black
- B. Apply to face and back surfaces of each Member.
- C. Air-dry Stain without artificial heat.

2.6 SIDING & PANELING FABRICATION

- A. Cut with sharp, ultra-fine, Carbide-tipped Finishing Saw.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

- A. Verify that Structure and Surfaces to receive Siding & Paneling are straight, plumb, true, solid, rigid, dry, and otherwise properly prepared.
- B. Prior to starting Work, notify General Contractor and Owner about defects requiring correction.
- C. Do not start Work until conditions are satisfactory.

3.2 PROTECTING ADJACENT WORK

- A. Protect against damage and discoloration caused by Work of this Section.

3.3 FURRING INSTALATION

- A. Install as shown on Drawings.
- B. Space 16 inches o.c. maximum.
- C. Locate Joints over solid bearing.
- D. Secure to Substrate with Fasteners.

3.4 LAYOUT

- A. Wall Siding & Paneling: Vertical.
- B. Exterior Soffits: Run perpendicular to adjacent Walls.

3.5 SIDING & PANELING INSTALLATION

- A. Follow Siding & Paneling Manufacturer's instructions.
- B. Fit neatly at Joints and against Trim.
- C. Accurately scribe to adjacent Surface irregularities.
- D. Locate Joints over solid bearing.
- E. Fit accurately and neatly around any Projections through Siding. & Paneling.
- F. Secure Siding & Paneling with 2-each face-applied Fasteners located 1 inch from each Board-edge, and spaced 16 inches o.c. (max.)
- G. Drive Fasteners flush with Siding & Paneling face.
- H. Trim External and Internal Corners.

3.6 TRIM INSTALLATION

- A. Install as shown on Drawings.
- B. Fit carefully at Joints and against other Members.
- C. Locate Joints on Solid Bearing.
- D. Bevel-cut and glue End Joints.

3.7 TOUCH-UP

- A. Touch-up Field-cuts and damaged Factory-applied Finishes.

3.8 PRODUCT CLEANING & REPAIRING

- A. Wipe exposed Siding & Paneling surface with clean and wet Rag to remove any Soil or Foreign Matter.
- B. Including Work of other Trades, clean, repair and touch-up, or replace when directed, Products which have been soiled, discolored, or damaged by Work of this Section.
- C. Remove Debris from Project Site upon Work completion, or sooner if directed.

END OF SECTION 06 26 00

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SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior standing and running trim.
 - 2. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
 - 3. Shop priming of interior architectural woodwork.
 - 4. Shop finishing of interior architectural woodwork.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Anchors.
 - 2. Adhesives.
 - 3. Shop finishing materials.
 - 4. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
 - 2. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
- C. Shop Drawings:
 - 1. Include the following:
 - a. Dimensioned plans, elevations, and sections.
 - b. Attachment details.
 - 2. Show large-scale details.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
- D. Samples: For each exposed product and for each shop-applied color and finish specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For the following:
 - 1. Composite wood products.
 - 2. Adhesives.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups of typical interior architectural woodwork as shown on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

1.5 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of the construction period.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

2.2 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Architectural Woodwork Standards Grade: Custom.
- B. Hardwood Lumber:
 - 1. Species: White oak.
 - 2. Cut: Plain sliced/plain sawn.
 - 3. Wood Moisture Content: 5 to 10 percent.
 - 4. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.
 - 5. For trim items other than base wider than available lumber, use veneered construction. Do not glue for width.
 - 6. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.

2.3 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Nailers: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
 - 1. Preservative Treatment: Provide softwood lumber treated by pressure process, AWP A U1; Use Category UC3b.
 - a. Provide where in contact with concrete or masonry.
 - b. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
 - c. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - d. Mark lumber with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee's (ALSC) Board of Review.
- B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
 - 1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
 - 2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- D. Adhesives: Do not use adhesives that contain urea formaldehyde.
- E. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.
 - 1. Verify adhesives have a VOC content of 70 g/L or less.

2.4 FABRICATION

- A. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.
 - 1. Ease edges to radius indicated for the following:
 - a. Edges of Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.
 - b. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).
- B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.
 - 1. Disassemble components only as necessary for shipment and installation.
 - 2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
 - 3. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.
 - a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
 - b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.5 SHOP PRIMING

- A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
- B. Interior Architectural Woodwork for Transparent Finish: Shop-seal concealed surfaces with required pretreatments and first coat of finish as specified in Section 09 93 00 "Staining and Transparent Finishing."
 - 1. Backpriming: Apply one coat of sealer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

2.6 SHOP FINISHING

- A. Finish interior architectural woodwork with transparent finish at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.
- C. Transparent Finish:
 - 1. Architectural Woodwork Standards Grade: Custom.
 - 2. Finish System - 5: Varnish, Conversion.
 - 3. Finish System - 7: Vinyl, Catalyzed.
 - 4. Finish System - 12: Polyurethane, Water Based.
 - 5. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
 - 6. Staining: Match Architect's sample.
 - 7. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
 - 8. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
 - 9. Sheen: Semigloss, 46-60 gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.
- B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.2 INSTALLATION

- A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.
- B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.
- C. Install interior architectural woodwork level, plumb, true in line, and without distortion.
 - 1. Shim as required with concealed shims.
 - 2. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes in accordance with AWPA M4.

- F. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.
 - 1. Secure with countersunk, concealed fasteners and blind nailing.
 - 2. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with interior architectural woodwork.
 - 3. For shop-finished items, use filler matching finish of items being installed.

- G. Standing and Running Trim:
 - 1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
 - 2. Do not use pieces less than 60 inches (1500 mm) long, except where shorter single-length pieces are necessary.
 - 3. Scarf running joints and stagger in adjacent and related members.
 - 4. Fill gaps, if any, between top of base and wall with latex sealant, painted to match wall.
 - 5. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).

END OF SECTION 06 40 23

SECTION 06 41 16 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-clad architectural cabinets.
 - 2. Cabinet hardware and accessories.
 - 3. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Sustainable Design Submittals:
 - 1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - 2. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
- D. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Research reports.
- B. Field quality control reports.

1.4 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Certified Wood: Verify wood products contain not less than 60 percent certified wood tracked through a chain-of-custody process. Provide certified wood documentation from sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
- D. Type of Construction: Face frame.
- E. Door and Drawer-Front Style: Reveal overlay.
 - 1. Reveal Dimension: 1/2 inch (13 mm).
- F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

- G. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Postformed Surfaces: Grade HGP.
 - 3. Vertical Surfaces: Grade HGS.
 - 4. Edges: PVC tape, 0.018-inch (0.460-mm) minimum thickness, matching laminate in color, pattern, and finish.
 - 5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
- H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued dovetail joints.
- J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Wood grains, matte finish.
 - b. Patterns, matte finish.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Recycled Content of MDF and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - 2. Composite Wood Products: Verify products are made without added urea formaldehyde.
 - 3. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
 - 4. Softwood Plywood: DOC PS 1, medium-density overlay.
 - 5. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.3 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware."
- B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening.
- C. Wire Pulls: Back mounted, solid metal, 5 inches (127 mm) long, 2-1/2 inches (63.5 mm) deep, and 5/16 inch (8 mm) in diameter.
- D. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
- E. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- F. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Standard Duty (Grade 1 and Grade 2): Side mount and extending under bottom edge of drawer.
 - 2. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Undermount.
 - a. Type: Full extension.
 - b. Material: Zinc-plated ball bearing slides.
 - c. Motion Feature: Self-closing mechanism.
- G. Door Locks: ANSI/BHMA A156.11, E07121.
- H. Drawer Locks: ANSI/BHMA A156.11, E07041.

- I. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- J. Grommets for Cable Passage: 2-inch (51-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Color: Black.
- K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
 - 1. Satin Brass, Blackened, Bright Relieved, Clear Coated: ANSI/BHMA 610 for brass base; ANSI/BHMA 636 for steel base.
- L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesives: Do not use adhesives that contain urea formaldehyde.
- D. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
 - 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.5 FABRICATION

- A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- C. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA's "Glazing Manual."
 - 1. For glass in frames, secure glass with removable stops.
 - 2. For exposed glass edges, polish and grind smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.
- B. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into wood framing, blocking, or hanging strips.

END OF SECTION 06 41 16

SECTION 07 11 13 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cold-applied, cut-back-asphalt dampproofing.
 - 2. Cold-applied, emulsified-asphalt dampproofing.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.2 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

- A. Trowel Coats: ASTM D4586/D4586M, Type I, Class 1, fibered.
- B. Brush and Spray Coats: ASTM D4479/D4479M, Type I, fibered.

2.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Trowel Coats: ASTM D1227, Type II, Class 1.
- B. Fibered Brush and Spray Coats: ASTM D1227, Type II, Class 1.
- C. Brush and Spray Coats: ASTM D1227, Type III, Class 1.

2.4 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.
- B. Emulsified-Asphalt Primer: ASTM D1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.
- C. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

- A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.
 - 1. Apply dampproofing to provide continuous plane of protection.
 - 2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
- B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches (150 mm) over outside face of footing.
 - 1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 - 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- (200-mm-

) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

- C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
 - 1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
 - 2. Lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.

3.2 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

- A. Concrete Foundations: Apply two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).
- B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat or primer and one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).
- C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
- D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

3.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Concrete Foundations: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).
- B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat primer and one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or primer and one trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m).
- C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
- D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

3.4 PROTECTION COURSE INSTALLATION

- A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

END OF SECTION 07 11 13

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Extruded polystyrene foam-plastic board insulation.
 - 2. Polyisocyanurate foam-plastic board insulation.
 - 3. Mineral-wool blanket insulation.
 - 4. Mineral-wool board insulation.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Extruded polystyrene foam-plastic board insulation.
 - 2. Molded (expanded) polystyrene foam-plastic board insulation.
 - 3. Polyisocyanurate foam-plastic board insulation.
 - 4. Mineral-wool blanket insulation.
 - 5. Mineral-wool board insulation.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

- A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
 - 1. Sign, date, and post the certification in a conspicuous location on Project site.
- B. Product test reports.
- C. Research reports.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

- A. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, 25-psi (173-kPa) minimum compressive strength; unfaced.
 - 1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
 - 2. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
 - 3. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - 4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

- A. Polyisocyanurate Board Insulation, Foil Faced: ASTM C1289, foil faced, Type I, Class 1 or 2.
 - 1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - 2. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.3 MINERAL-WOOL BLANKET INSULATION

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 90 percent.
- B. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.

1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
 2. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
 3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.
- C. Mineral-Wool Blanket Insulation, Reinforced-Foil Faced: ASTM C665, Type III (reflective faced); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
 2. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
 3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.4 MINERAL-WOOL BOARD INSULATION

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 40 percent.
- B. Mineral-Wool Board Insulation, Types IA and IB, Unfaced: ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.
1. Nominal Density: 4 lb/cu. ft. (64 kg/cu. m).
 2. Flame-Spread Index: Not more than 15 when tested in accordance with ASTM E84.
 3. Smoke-Developed Index: Not more than zero when tested in accordance with ASTM E84.
 4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.
- C. Mineral-Wool Board Insulation, Types IA and IB, Faced: ASTM C612, Types IA and IB; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder.
1. Nominal Density: 4 lb/cu. ft. (64 kg/cu. m).
 2. Flame-Spread Index: Not more than 15 when tested in accordance with ASTM E84.
 3. Smoke-Developed Index: Not more than zero when tested in accordance with ASTM E84.
 4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.5 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
 2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
 3. Polyurethane Pour-In-Place Insulation: Closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84, specifically formulated for pour-in-place applications.
- B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.
- C. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
1. Verify adhesives have a VOC content of 70 g/L or less.
- D. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.

3.3 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face and as recommended by manufacturer.
 - 1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.
 - 3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 04 20 00 "Unit Masonry."
- B. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches (100 mm) from each corner of board insulation, at center of board, and as recommended by manufacturer.
 - 1. Fit courses of insulation between masonry wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.

3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 - 5. For wood-framed construction, install blankets according to ASTM C1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
 - 6. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward interior of construction.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

END OF SECTION 07 21 00

SECTION 07 27 26 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vapor-permeable, fluid-applied air barriers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For coatings, indicating VOC content.
 - 2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For air-barrier assemblies.
 - 1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 - 1. Build integrated mockups of exterior wall assembly, 150 sq. ft. (14 sq. m), incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
 - b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. VOC Content: 100 g/L or less.

2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction

material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E2357.

2.3 MEDIUM-BUILD AIR BARRIERS, VAPOR PERMEABLE

- A. Medium-Build, Vapor-Permeable Air Barrier: Synthetic polymer material with an installed dry film thickness, according to manufacturer's written instructions, of 17 to 30 mils (0.4 to 0.8 mm) over smooth, void-free substrates.

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. 3M Industrial Adhesives and Tapes Division.
- b. DuPont Safety & Construction.
- c. GE Construction Sealants; Momentive Performance Materials Inc.
- d. Sto Corp.
- e. W.R. Meadows, Inc.

2. Physical and Performance Properties:

- a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E2178.
- b. Vapor Permeance: Minimum 10 perms (580 ng/Pa x s x sq. m); ASTM E96/E96M, Desiccant Method, Procedure A.
- c. Ultimate Elongation: Minimum 250 percent; ASTM D412, Die C.
- d. Adhesion to Substrate: Minimum 30 lbf/sq. in. (207 kPa) when tested according to ASTM D4541.
- e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- f. UV Resistance: Can be exposed to sunlight for 180 days according to manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- F. Bridge discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.2 INSTALLATION

- A. Install materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
 3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- C. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.
- D. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.
- E. Medium-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply an increased thickness of air-barrier material in full contact around protrusions such as masonry ties.
1. Vapor-Permeable, Medium-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, applied in one or more equal coats. Apply additional material as needed to achieve void- and pinhole-free surface, but do not exceed thickness on which required vapor permeability is based.
- F. Do not cover air barrier until it has been tested and inspected by testing agency.
- G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: As determined by testing agency from among the following tests:
1. Air-barrier dry film thickness.
 2. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber depressurization using detection liquids.
 3. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783 or ASTM E2357.
 4. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.
- C. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- E. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
- B. Remove masking materials after installation.

END OF SECTION 07 27 26

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and other contract documents, listed in the agreement between the Owner and Contractor, apply to this section.

1.2 SUMMARY

- A. Section includes:
 - 1. Preformed metal wall panels.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Conference: Conduct conference at project site.
- B. Coordination:
 - 1. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
 - 2. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leak proof, secure, and noncorrosive installation.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, accessories and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, prepared on samples of size indicated below:
 - 1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.
- E. Qualification Data: For Installer.
- F. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- G. Filed quality – control reports.
- H. Sample Warranties: No Warranties: A 606 – 4 Weathering Steel

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build quality mockup; to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver components, metal panels and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Store metal panels in a manner to prevent bending, warping, twisting and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weather tight and ventilated covering. Store metal panels to ensure dryness with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

PART 2 – PRODUCTS

2.1 BASIS-OF-DESIGN MANUFACTURER

- A. Western States Decking, Inc., DBA - Western States Metal Roofing, 901 W. Watkins St., Phoenix, AZ 85007; Phone: (877) 787-5467; Fax: (602) 261-7726. Email: sales@cortenroofing.com Website: www.cortenroofing.com
- B. Substitutions: In accordance with contract documents.

2.2 METAL WALL PANELS

- A. Flush- Profile: Formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
 - 1. Panel Designation: Rustwall ® Panel
 - 2. Steel Sheet: A 606-4 Weathering Steel: ASTM A 606-04 High Strength Low Alloy Weathering Steel
 - a. Nominal Thickness: 22 gauge
 - 3. Panel Width: 18 inches
 - 4. Panel Height: Nominal 1.0 inch

2.3 ACCESSORIES

- A. Panel Accessories: Provide components required for a complete, weather tight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 3. Closure Strips: Closed- cell, expanded, cellular, rubber, or cross linked, polyolefin- foam or cell laminated polyethylene; minimum 1 inch thick, flexible closure strip; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weather tight construction.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish systems adjacent metal panels.
- C. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory- applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- D. Panel Sealants: Provide sealant type recommended by manufacturers that are compatible with panel materials, are non-staining and do not damage panel finish.
- E. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic.

2.4 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturers standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendation in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one- half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 - 1. A 606 – 4 Weathering Steel or Stainless Steel

PART 3- EXECUTION

3.1 EXAMINATION

- A. Examine substrates, area, and conditions, with installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the work.
 - 1. Examine wall framing to verify that girths, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerance required by metal wall panel manufacturer.

2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacture.
 - a. Verify that air or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports; Install sub framing, furring and other miscellaneous panel support members and anchorage according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the work securely in place, with provisions for thermal and structural movement.
- B. Fasteners:
 1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use stainless steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
 1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weather tight enclosure.
 2. Provide metal backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads or panels. Install screws in predrilled holes.
 5. Flash and seal pans with weather closures at perimeter of all openings.
- E. Accessory Installation: install accessories with positive anchorage to building and weather tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 1. Install components, required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- F. Flashing and Trim: Comply with performance requirements manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints and seams that are permanently water-tight.
 1. Install exposed flashing and trim that is without 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 achieve waterproof performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joint at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13.13

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SECTION 07 41 13.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standing-seam metal roof panels.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
- C. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
- D. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 24 percent.
- B. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 23 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- C. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.
- D. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
 - 1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
 - 2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.
- E. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- F. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- G. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- H. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.
- I. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 60.
- J. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
 - 1. Fire/Windstorm Classification: Class 1A- 90.
 - 2. Hail Resistance: MH.
- K. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
 - 2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.
- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by

mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

1. Basis-of-Design: DMC150SL by Drexel Metals
2. 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. CENTRIA
 - b. Drexel Metals
 - c. Englert
 - d. MBCI
 - e. McElroy Metal, Inc.
 - f. Morin – A Kingspan Group
 - g. PAC-CLAD; Petersen Aluminum
 - h. Equal as approved by Architect prior to bidding.
3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Nominal Thickness: 0.025 inch (0.635 mm).
 - b. Exterior Finish: Three-coat fluoropolymer.
 - c. Color: Weathered Zinc .
4. Clips: One-piece fixed to accommodate thermal movement.
 - a. Material: 0.028-inch- (0.71-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
5. Panel Coverage: 12 inches (305 mm).
6. Panel Height: 1.5 inches (38 mm).

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D1970.
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match metal roof panels.
- E. Panel Fasteners: Self-tapping screws designed to withstand design loads.

- F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 - 2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.6 FINISHES

- A. Panels and Accessories:
 - 1. Three-Coat Fluoropolymer: AAMA 621 or AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat.
 - 2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply over the entire roof surface.
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
- C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

3.3 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

- A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 - 4. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.

- c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
 - B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- 3.4 CLEANING AND PROTECTION
- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 07 41 13.16

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SECTION 07 54 23 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Adhered thermoplastic polyolefin (TPO) roofing system.
 - 2. Mechanically fastened, thermoplastic polyolefin (TPO) roofing system.
 - 3. Roof insulation.
 - 4. Cover board.
 - 5. Walkways.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For insulation and roof system component fasteners, include copy of SPRI's Directory of Roof Assemblies listing.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
 - 3. Product Data: For adhesives and sealants, indicating VOC content.
 - 4. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
 - 5. Environmental Product Declaration: For each product.
- C. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
 - 1. Layout and thickness of insulation.
 - 2. Base flashings and membrane termination details.
 - 3. Flashing details at penetrations.
 - 4. Tapered insulation layout, thickness, and slopes.
 - 5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
 - 6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
 - 7. Tie-in with adjoining air barrier.
- D. Samples: For the following products:
 - 1. Roof membrane and flashings, of color required.
 - 2. Walkway pads or rolls, of color required.
- E. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Certificates:
 - 1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of compliance with performance requirements.
 - 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- B. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

- C. Research reports.
 - D. Field Test Reports:
 - 1. Concrete internal relative humidity test reports.
 - 2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
 - E. Field quality-control reports.
 - F. Sample warranties.
- 1.5 CLOSEOUT SUBMITTALS
- A. Maintenance data.
 - B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- 1.7 WARRANTY
- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
- B. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
 - 1. Zone 1 (Roof Area Field): -16.8 lbf/sq. ft. (kPa/sq. m).
 - 2. Zone 2 (Roof Area Perimeter): -28.2 lbf/sq. ft. (kPa/sq. m).
 - a. Ice Support Building Location: From roof edge to 16'-0" inside roof edge.
 - b. Retail Building Location: From roof edge to 7.2 feet inside roof edge.
 - 3. Zone 3 (Roof Area Corners): -42.4 lbf/sq. ft. (kPa/sq. m).
 - a. Ice Support Building Location: 16.0 feet in each direction from building corner.
 - b. Retail Building Location: 7.2 feet in each direction from building corner.
- D. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and shall be listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.
 - 1. Wind Uplift Load Capacity: 105 psf.
- E. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 64 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- F. ENERGY STAR Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
- G. Energy Performance: Roofing system shall have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.

- H. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

- A. TPO Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, TPO sheet.
 - 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. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. GAF.
 - d. Johns Manville; a Berkshire Hathaway company.
 - e. Versico Roofing Systems.
 - 2. Thickness: 60 mils (1.5 mm), nominal.
 - 3. Exposed Face Color: Tan.

2.3 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
 - 2. Verify adhesives and sealants comply with the following limits for VOC content:
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Contact Adhesives: 80 g/L.
 - f. PVC Welding Compounds: 510 g/L.
 - g. Other Adhesives: 250 g/L.
 - h. Single-Ply Roof Membrane Sealants: 450 g/L.
 - i. Nonmembrane Roof Sealants: 300 g/L.
 - j. Sealant Primers for Nonporous Substrates: 250 g/L.
 - k. Sealant Primers for Porous Substrates: 775 g/L.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Bonding Adhesive: Manufacturer's standard, water based.
- E. Slip Sheet: Manufacturer's standard, of thickness required for application.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 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. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. GAF.

- d. Johns Manville; a Berkshire Hathaway company.
- 2. Size: 48 by 96 inches (1219 by 2438 mm).
- 3. Thickness:
 - a. Base Layer: 1-1/2 inches (38 mm).
 - b. Upper Layer: 1-1/2 inches (38 mm) .
- B. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: Match roof insulation.
 - 2. Minimum Thickness: 1/4 inch (6.35 mm).
 - 3. Slope:
 - a. Roof Field: As indicated on Drawings.
 - b. Saddles and Crickets: As indicated on Drawings.

2.5 INSULATION ACCESSORIES

- A. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
 - 2. Verify adhesives and sealants comply with the following limits for VOC content:
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Contact Adhesives: 80 g/L.
 - f. PVC Welding Compounds: 510 g/L.
 - g. Other Adhesives: 250 g/L.
 - h. Single-Ply Roof Membrane Sealants: 450 g/L.
 - i. Nonmembrane Roof Sealants: 300 g/L.
 - j. Sealant Primers for Nonporous Substrates: 250 g/L.
 - k. Sealant Primers for Porous Substrates: 775 g/L.
- C. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.
- D.
 - 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. Georgia-Pacific Gypsum LLC.
 - b. National Gypsum Company.
 - c. USG Corporation.
 - 2. Thickness: 1/2 inch (13 mm).
 - 3. Surface Finish: Factory primed.

2.6 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.
 - 1. Size: Approximately 36 by 60 inches (914 by 1524 mm).
 - 2. Color: Contrasting with roof membrane.
 - 3. Provide around all mechanical equipment on the roof to be maintained and walkway paths to each piece of equipment from south wall of parapet.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

3.2 PREPARATION

- A. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
 - 1. Submit test result within 24 hours after performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, SPRI's Directory of Roof Assemblies listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.
- C. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 07 27 26 "Fluid-Applied Membrane Air Barriers."

3.4 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Wood Panel Decking:
 - 1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to wood panel decks.
 - a. Fasten slip sheet according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
 - 2. Install base layer of insulation with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
 - a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
 - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
 - 1) Trim insulation so that water flow is unrestricted.
 - e. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
 - f. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
 - 3. Mechanically attach base layer of insulation using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to wood panel decks.
 - a. Fasten insulation according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
 - b. Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
 - 4. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.
 - a. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
 - g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

- h. Loosely lay each layer of insulation units over substrate.
- i. Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.5 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.
 - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.
 - 3. Cut and fit cover board tight to nailers, projections, and penetrations.
 - 4. Adhere cover board to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - a. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
 - b. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - c. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- B. Install slip sheet over cover board and beneath roof membrane.

3.6 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over vertical surfaces to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel and Owner's testing and inspection agency.
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.
- G. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- H. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
 - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

- J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.7 INSTALLATION OF MECHANICALLY FASTENED ROOF MEMBRANE

- A. Mechanically fasten roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. For in-splice attachment, install roof membrane with long dimension perpendicular to steel roof deck flutes.
- D. Start installation of roofing in presence of roofing system manufacturer's technical personnel and Owners testing and inspection agency.
- E. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- F. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.
- G. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- H. In-Seam Attachment: Secure one edge of TPO sheet using fastening plates or metal battens centered within seam, and mechanically fasten TPO sheet to roof deck.
- I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.
 - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.8 INSTALLATION OF BASE FLASHING

- 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 sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 INSTALLATION OF WALKWAYS

- A. Flexible Walkways:
 - 1. Install flexible walkways at the following locations:
 - a. Retain one or more subparagraphs below. Revise to suit Project.
 - b. Perimeter of each rooftop unit.
 - c. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - d. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - e. Top and bottom of each roof access ladder.

- f. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - g. Locations indicated on Drawings.
 - h. As required by roof membrane manufacturer's warranty requirements.
- 2. Provide 6-inch (76-mm) clearance between adjoining pads.
- 3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 54 23

SECTION 07 71 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copings.
 - 2. Roof-edge specialties.
 - 3. Roof-edge drainage systems.
 - 4. Reglets and counterflashings.
- B. Preinstallation Conference: Conduct conference at Project site.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. <Double click to insert sustainable design text for recycled content.>
- C. Shop Drawings: For roof specialties.
 - 1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
- D. Samples: For each type of roof specialty and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For tests performed by a qualified testing agency.
- B. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are SPRI ES-1 tested to specified design pressure.

1.6 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 07 54 23, "Thermoplastic-Polyolefin (TPO) Roofing."
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

- B. SPRI Wind Design Standard: Manufacture and install copings and roof-edge specialties tested according to SPRI ES-1 and capable of resisting the following design pressures:
 - 1. Design Pressure: As indicated on Drawings.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COPINGS

- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
 - 1. Metallic-Coated Steel Sheet Coping Caps: Zinc-coated (galvanized) steel, nominal 0.034-inch (0.86-mm) thickness.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Three-coat fluoropolymer.
 - c. Color: As selected by Architect from manufacturer's full range.
 - 2. Corners: Factory mitered and continuously welded.
 - 3. Coping-Cap Attachment Method: face leg hooked to continuous cleat with back leg fastener exposed, fabricated from coping-cap material.
 - a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.
 - b. Face-Leg Cleats: Concealed, continuous galvanized-steel sheet.

2.3 ROOF-EDGE SPECIALTIES

- A. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous metal receiver with integral drip-edge cleat to engage fascia cover and secure single-ply roof membrane. Provide matching corner units.
 - 1. Basis-of-Design: MAC Metal Architectural (www.macmetalarchitectural.com). See specific model numbers as indicated on the Contract Documents.
 - 2. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal 0.034-inch (0.86-mm) thickness.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Three-coat fluoropolymer.
 - c. Color: As selected by Architect from manufacturer's full range.
 - 3. Corners: Factory mitered and continuously welded.
 - 4. Splice Plates: Exposed, of same material, finish, and shape as fascia cover.
 - 5. Receiver: Galvanized-steel sheet, nominal 0.040-inch (1.02-mm) thickness.
 - 6. Fascia Accessories: Wall cap.

2.4 ROOF-EDGE DRAINAGE SYSTEMS

- A. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
 - 1. Zinc-Coated Steel: Nominal 0.034-inch (0.86-mm) thickness.
 - 2. Gutter Profile: Half-round highback according to SMACNA's "Architectural Sheet Metal Manual."
 - 3. Corners: Factory mitered and continuously welded.
 - 4. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.
 - 5. Gutter Accessories: Continuous screened leaf guard with sheet metal frame and Bronze wire ball downspout strainer.
- B. Downspouts: Plain round complete with elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
 - 1. Zinc-Coated Steel: Nominal 0.034-inch (0.86-mm) thickness.
- C. Zinc-Coated Steel Finish: Three-coat fluoropolymer.

1. Color: As selected by Architect from manufacturer's full range .

2.5 REGLETS AND COUNTERFLASHINGS

- A. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
 1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
 2. Corners: Factory mitered and continuously welded.
 3. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
- B. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into and compress against base flashings with joints lapped, from the following exposed metal:
 1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.
- C. Accessories:
 1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- D. Zinc-Coated Steel Finish: Three-coat fluoropolymer.
 1. Color: As selected by Architect from manufacturer's full range.

2.6 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation.

2.7 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 deg F (116 deg C).
 2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F (29 deg C).
- B. Slip Sheet: Rosin-sized building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum.

2.8 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 2. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 3. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
 4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.9 FINISHES

- A. Coil-Coated Galvanized-Steel Sheet Finishes:
 - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A755/A755M and coating and resin manufacturers' written instructions.
 - a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply continuously under copings, roof-edge specialties and reglets and counterflashings.
 - 2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.
- B. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

3.2 INSTALLATION, GENERAL

- A. Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 - 4. Torch cutting of roof specialties is not permitted.
 - 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
 - 1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
 - 2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

3.3 INSTALLATION OF COPING

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
 - 1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

3.4 INSTALLATION OF ROOF-EDGE SPECIALITIES

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.5 INSTALLATION OF ROOF-EDGE DRAINAGE-SYSTEM

- A. Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches (610 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
 - 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.
 - 2. Install continuous leaf guards on gutters with noncorrosive fasteners, hinged to swing open for cleaning gutters.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
 - 1. Provide elbows at base of downspouts at grade to direct water away from building.
 - 2. Connect downspouts to underground drainage system indicated.

3.6 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed.

END OF SECTION 07 71 00

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SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof curbs.
 - 2. Equipment supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
- B. Shop Drawings: For roof accessories.
- C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed deck-mounting flange at perimeter bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.064 inch (1.63 mm) thick.
 - 1. Finish: Mill phosphatized.
- D. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
 - 3. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
 - 4. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
 - 5. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 - 6. Nailer: Factory-installed wood nailer along top flange of curb or under top flange on side of curb, continuous around curb perimeter.
 - 7. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
 - 8. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.

9. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.2 EQUIPMENT SUPPORTS

- A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed structure-mounting flange at bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.064 inch (1.63 mm) thick.
 1. Finish: Mill phosphatized.
- D. Construction:
 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 2. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
 3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
 4. Nailer: Factory-installed continuous wood nailers 3-1/2 inches (90 mm) wide on top flange of equipment supports or under top flange on side of curb, continuous around support perimeter.
 5. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
 6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
 8. Fabricate equipment supports to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
 9. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.3 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation.
 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
- B. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- C. Steel Tube: ASTM A500/A500M, round tube.
- D. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- E. Steel Pipe: ASTM A53/A53M, galvanized.

2.4 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
- D. Underlayment:

1. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
- E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
- F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- G. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 1. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
- C. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 13 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 72 00

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SECTION 07 72 53 - SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
 - 1. Include details of rail-type snow guards.
- C. Samples:
 - 1. Rail-Type Snow Guards: Bracket, 12-inch- (300-mm-) long rail, and installation hardware.
 - a. For units with factory-applied finishes, submit manufacturer's standard color selections.
- D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.
- B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, applicable for attachment method, based on the following:
 - 1. Roof snow load.
 - 2. Snow drifting
 - 3. Roof slope.
 - 4. Roof type.
 - 5. Roof dimensions.
 - 6. Roofing substrate type and thickness.
 - 7. Snow guard type.
 - 8. Snow guard fastening method and strength.
 - 9. Snow guard spacing.
 - 10. Coefficient of Friction Between Snow and Roof Surface: 0.
 - 11. Factor of Safety: 2.
- B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 - 1. Snow Loads: As indicated on Drawings.

2.2 RAIL-TYPE SNOW GUARDS

- A. Rail-Type, Seam-Mounted Snow Guards:
 - 1. Subject to compliance with requirements, available manufacturer's offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Alpine Snow Guards
 - b. Berger Building Products
 - c. IceBlox, Inc.
 - d. PMC Industrias, Ltd.
 - e. TRA Snow and Sun, Inc.
 - 2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with two rails.
 - 3. Brackets and Baseplates: ASTM B209 (ASTM B209M) aluminum; mill finish.
 - 4. Bars: ASTM B221 (ASTM B221M) aluminum; mill finish.
 - a. Profile: Round.
 - 5. Seam clamps: ASTM B221 (ASTM B221M) aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install snow guards according to manufacturer's written instructions.
 - 1. Space rows as recommended by manufacturer.
- B. Attachment for Standing-Seam Metal Roofing:
 - 1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
 - 2. Pad-Type, Flat-Mounted Snow Guards:
 - a. Mechanically attach to metal roofing according to manufacturer's instructions.
 - 3. Rail-Type, Seam-Mounted Snow Guards:
 - a. Install brackets to vertical ribs in straight rows.
 - b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
 - c. Torque set screw according to manufacturer's instructions.
 - d. Install cross members to brackets.

END OF SECTION 07 72 53

SECTION 07 76 00 - REINFORCED PRECAST CONCRETE ROOF PAVERS, PEDESTAL SUPPORTED

PART 1 - GENERAL

1.1 SUMMARY

- A. Perform all work required for a complete system, as indicated by the Documents. Furnish all items necessary for the proper installation of the system.
- B. System shall consist of reinforced precast concrete roof pavers for pedestal set roof/deck installation.
- C. Related Sections:
 - 1. Section 07 54 23 Thermoplastic-Polyolefin (TPO) Roofing

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)

ASTM C33	Concrete Aggregates
ASTM C39	Concrete Compressive Strength
ASTM C144	Aggregate for Masonry Mortar
ASTM C150	Portland cement
ASTM C642	Water Absorption, Density, Voids in Hardened Conc
ASTM C666	Rapid Freeze/Thaw Resistance of Conc
ASTM C979	Pigments for Integrally Colored Concrete
ASTM C1028	Coefficient of Friction
ASTM A185	Steel Welded Wire Reinforcement for Concrete
- B. Paving installations shall be designed in consultation with a qualified engineer, in accordance with established roof paving design procedures.
- C. Refer to pedestal manufacturer's instructions for proper use of pedestals.

1.3 SUBMITTALS

- A. Initial Samples: Submit color board showing full line of colors and finishes for selection by Architect.
- B. Confirmation Samples: After selection of color and finish, submit two full-sized samples of each type of precast concrete roof pavers to show the full range of color and texture of unit for selection and approval. If sealer is to be applied to precast concrete roof pavers, apply sealer on one sample.
- C. Warranty: Provide certified copies of manufacturer's product warranties.
- D. Shop drawings
 - 1. Layout drawings showing pattern of pavers for each paved area, indicate pavers requiring cutting, indicate setting bed methods in each area, and indicate drainage. Include details of setting beds. Indicate details at curbs and vertical surfaces as applicable.

1.4 MOCK-UP

- A. Install a 6 ft x 10 ft minimum paver area as described in Article 3.2. Mock-up area to be used to determine joint sizes, lines, laying pattern, color(s) and texture of the job. Mock-up area to be the standard from which the work will be judged. Consideration will be given with regard to differences in age of materials from time of mock-up construction to the time of actual product delivery and installation.

1.5 SUBSTITUTIONS

- A. Proposed substitutions: No known equal.

1.6 QUALITY ASSURANCE

- A. Compliance with Regulations: Comply with requirements of state and local building codes and with rules and regulations relating to building accessibility.

B. Qualifications of Manufacturer

1. Company specializing in manufacture of precast concrete paving units with a minimum of 10 continuous years of documented experience.
2. Must have a minimum of 5 years of documented experience manufacturing large-scale segmental paving units.

C. Qualifications of Subcontractor: Subcontractor shall submit evidence of skill and not less than 5 years of experience in this product type.

D. Pre-installation Conference: As directed by the Architect

E. Precast concrete paving units shall have a compressive strength of 5,000 psi minimum.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials to the installation site in the manufacturer's original packaging. Packaging shall contain manufacturer's name, customer name, order, identification number, and other related information.

B. Handle and store precast concrete roof pavers in accordance with manufacturer's recommendations.

1.8 WARRANTY

A. Provide warranty covering pedestal set precast concrete roof pavers against defects in material and workmanship for a period of 5 years. Unusual abuse and neglect are excepted.

PART 2 - PRODUCTS

2.1 BASIS-OF-DESIGN MANUFACTURER

Stepstone, Inc.
17025 South Main Street, Gardena, CA 90248
(310) 327-7474 (800) 572-9029 FAX (310) 217-1424
www.stepstoneinc.com

2.2 MATERIALS

A. Precast concrete roof pavers shall be Reinforced Precast Concrete Roof Pavers, pedestal supported; consisting of Portland cement, aggregate, and color admixtures.

1. Portland Cement: ASTM C 150, Type III, high early strength.
2. Aggregate: ASTM C 33.
3. Color Admixture: By Davis Colors, or equal, as required to achieve color as selected.
4. Aggregate for exposed aggregate surface: As selected
5. Zinc-Plated Welded wire mesh panel: ASTM A 185
6. Adjustable Deck Supports (Pedestals): By Bison, Appian Way Sales, PAVE-EL or equal:

B. Precast Concrete Roof Paver style

1. California Architectural Pavers: 2" thick
2. Pavers shall have radius top edge to reduce chipping.
3. All pavers have drafted sides.

2.3 COLORS AND FINISHES

A. Colors: Davis Colors (or equal), integral color admixture. Integral color shall be throughout entire product. Finish color shall not be added as a face mix.

<u>With Slag</u>		<u>Without Slag</u>		<u>Slate-Finish (Sonorastone)</u>	
1401	Granada White	1801	Granada White	1501	Granada White
1404	French Gray	1804	French Gray	1504	French Gray
1405	Iceberg Green	1805	Iceberg Green	1506	Almond
1406	Almond	1806	Almond	1507	Cafe Brown
1407	Cafe Brown	1807	Cafe Brown	1510	Caramel
1410	Caramel	1810	Caramel	1512	Agave
1412	Agave	1812	Agave	1513	Porcelain
1413	Porcelain	1813	Porcelain	1516	Brick Red
1416	Brick Red	1816	Brick Red	1521	Kona
1421	Kona	1821	Kona	1524	Pebble
1424	Pebble	1824	Pebble	1525	Adobe
1425	Adobe	1825	Adobe		

- B. Finishes: Walking surfaces of precast concrete paving slab shall have minimum coefficient of friction of 0.60, wet and dry. Selected by Architect after review of samples from the following options:

1. Sandblasted (Light, Medium or Heavy).
2. Slate, also known as "Sonorastone"
3. Exposed aggregate
4. False Joint Narrow Modular

- A. Field Application of Sealer

1. In geographic regions exposed to freeze-thaw conditions field-applied sealing the entire paving area, including joints, after installation is mandatory.
2. Conform to sealer manufacturer's recommendations for application and maintenance of sealer.

2.4 PHYSICAL PROPERTIES

- A. Compressive strength: Minimum 5,000 psi.

- B. Size and Finish Schedule:

Size	Sandblast	Exposed Agg	Slate	False Joint NMP	False Joint
23-7/8" x 35-7/8" x 2"	X	X	X		X

- C. Unit size: Within 1/8" of designated length, width and thickness.

- D. Weight: 2" thick: 22 pounds per square foot

- E. Water absorption: Not more than 6.0 % average, not more than 7.0 % for any individual unit for standard colors.

- F. Reinforced California Architectural Pedestal Set Pavers will contain on average 5% entrained air, with no individual piece under 4%.

- G. Resistance to Freeze-Thaw: Reinforced California Architectural Pedestal Set Pavers will resist 300 freeze thaw cycles in accordance with ASTM C666 Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

2.5 FABRICATION

- A. Reinforced California Architectural Pedestal Set Pavers shall be fabricated of cement conforming to ASTM C 150, Type III, aggregates conforming to ASTM C 33, and pigments for integrally colored concrete conforming to ASTM C979.

2.6 SOURCE QUALITY CONTROL

- A. Concrete for Reinforced California Architectural Pedestal Set Pavers shall be tested frequently to assure that mixes provide units having not less than 5,000 psi compressive strength at 28 days (average test strength not less than 4,500 psi).
- B. Minor chips, hairline cracks, air voids and slight variations in color and finish are normal in precast concrete. When viewed in typical daylight illumination from a distance of 20 feet, minor chips, hairline cracks and air voids that cannot be seen with the naked eye are not grounds for rejection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify all elevations, required pedestal heights and deck dimensions before commencing work.
- D. Reinforced California Architectural Pedestal Set Pavers specified are to be used only in pedestrian traffic areas.

3.2 INSTALLATION - GENERAL

- A. Installation shall comply with requirements of applicable building codes and state and local jurisdictions.
- B. Reinforced California Architectural Pedestal Set Pavers can span a maximum of 36". Pavers larger than 36" require mid-span pedestal support.
- C. Refer to chosen pedestal manufacturer's installation specifications.
- D. Pedestrian decks must be restrained by perimeter blocking or walls on all sides. Lateral movement greater than one pedestal tab width is unacceptable and will be rejected.
- E. False joint pavers are designed to be used in situations where cutting is required and there is less than 12" that needs to be supported.
- F. Installation or anticipated installation of additional items on top of the deck, (such as planters, concrete benches, sculptures, hot tubs, grills, or industrial equipment) must be supported directly by additional pedestals that are in addition to the main deck paver pedestal system. Special consideration must be also given when installing equipment that vibrates. Total weights must be calculated and dispersed evenly over the number of pedestals needed to carry the expected weight. To avoid point loading, the use of planters or architectural features with 'feet' is not allowed. Failure to adequately support the additional weight of any such features or items may cause significant damage to the Reinforced California Architectural Pedestal Set Pavers underlying structure, or waterproofing system.

3.3 CLEANING

- A. Clean exposed surfaces of precast concrete paving units. Use cleaners appropriate for precast concrete finishes and colors. Acid based cleaners will alter finish and color.

3.4 SEALING

- A. Field-applied sealer for the prevention of freeze-thaw is optional in mild climates. If precast concrete paving units are factory sealed, test for compatibility before applying additional sealer.
- B. In geographic regions exposed to freeze-thaw conditions field-applied sealing the entire paving area, including field cut edges, after installation is mandatory in order to maintain Stepstone's warranty. Follow sealer manufacturer's instructions for application and maintenance of the sealer.

3.5 COMPLETION

- A. Protect precast concrete paving units from damage due to subsequent building operations.

- B. After installation and before completion, inspect precast concrete paving units for construction damage and obtain new precast concrete paving units if required.
- C. Immediately prior to final acceptance of project, clean precast concrete roof pavers.

END OF SECTION 07 76 00

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SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nonstaining silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Mildew-resistant joint sealants.
 - 4. Latex joint sealants.

1.2 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Sustainable Design Submittals:
 - 1. [Product Data](#): For sealants, indicating VOC content.
 - 2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
- C. Samples: For each kind and color of joint sealant required.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Preconstruction laboratory test reports.
- C. Preconstruction field-adhesion-test reports.
- D. Field-adhesion-test reports.
- E. Sample warranties.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 - 3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with masonry substrates.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

1.6 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. VOC Content: Verify sealants and sealant primers comply with the following:
 - 1. Architectural sealants have a VOC content of 250 g/L or less.
 - 2. Sealants and sealant primers for nonporous substrates have a VOC content of 250 g/L or less.
 - 3. Sealants and sealant primers for porous substrates have a VOC content of 775 g/L or less.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

2.3 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

2.4 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- C. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

2.5 JOINT-SEALANT BACKING

- A. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.6 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove laitance and form-release agents from concrete.
 - 2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.2 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with ASTM C1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 1. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.
 - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.4 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:

- a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in dimension stone cladding.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, P, 25, T, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry concrete walls.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Acrylic latex.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Butyl-rubber based.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Interior standard steel doors and frames.
 - 2. Exterior standard steel doors and frames.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Environmental Product Declaration: For each product.
- C. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
- D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.6 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ceco Door; ASSA ABLOY.

2. Curries Company; ASSA ABLOY.
3. North American Door Corp.
4. Rocky Mountain Metals, Inc.
5. Steelcraft; an Allegion brand.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
 1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. (2.16 W/K x sq. m) when tested according to ASTM C518.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..
 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm).
 - d. Edge Construction: Model 2, Seamless.
 - e. Core: Manufacturer's standard.
 - f. Fire-Rated Core: Manufacturer's standard vertical steel stiffener or laminated mineral board core for fire-rated doors.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
 - b. Construction: Full profile welded.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..
 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm), with minimum A60 (ZF180) coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Manufacturer's standard.
 - i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation or laminated mineral board core for fire-rated doors.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.
 - b. Construction: Full profile welded.

2.5 FRAME ANCHORS

- A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.6 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- H. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.7 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.8 STEEL FINISHES

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 - 2. Fire-Rated Openings: Install frames according to NFPA 80.
 - 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 4. Solidly pack mineral-fiber insulation inside frames.
 - 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 - 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 - 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, Section 5.2.
 - 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

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SECTION 08 14 33 - STILE AND RAIL WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior stile and rail wood doors.
 - 2. Interior fire-rated stile and rail wood doors.
 - 3. Factory fitting stile and rail wood doors to frames and factory machining for hardware.
 - 4. Factory finishing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Details of construction and glazing.
 - 2. Door frame construction.
 - 3. Factory-machining criteria.
 - 4. Factory- finishing specifications.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
 - 2. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
- C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data, including the following:
 - 1. Door schedule indicating door location, type, size, fire protection rating, and swing.
 - 2. Door elevations, dimensions and location of hardware, lite locations, and glazing thickness.
 - 3. Details of frame for each frame type, including dimensions and profile.
 - 4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 5. Clearances and undercuts.
 - 6. Requirements for veneer matching.
- D. Samples: For factory-finished doors.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For door inspector.
 - 1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
 - 2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, section 7.2.1.15.4.
 - 3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Field quality control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, section 7.2.1.15.4 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to UL 10C or NFPA 252.

2.2 MATERIALS

- A. Use only materials that comply with referenced standards and other requirements specified.
 - 1. Assemble exterior doors, including components, with wet-use adhesives complying with ASTM D5572 for finger joints and with ASTM D5751 for joints other than finger joints.
 - 2. Assemble interior doors, including components, with either dry-use or wet-use adhesives complying with ASTM D5572 for finger joints and with ASTM D5751 for joints other than finger joints.
- B. Adhesives: Do not use adhesives that contain urea formaldehyde.
- C. Composite Wood Products: Verify products are made without added urea formaldehyde.
- D. Panel Products: Any of the following unless otherwise indicated:
 - 1. Medium-density fiberboard (MDF,) complying with ANSI A208.2, Grade 130.
 - 2. Hardboard complying with ANSI A135.4.
 - 3. Veneer-core plywood.
- E. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

2.3 INTERIOR STILE AND RAIL WOOD DOORS

- A. Interior Stile and Rail Wood Doors: Interior stock doors complying with AWI, AWMAC, and WI's Architectural Woodwork Standards and with other requirements specified.
 - 1. Basis-of-Design: E106 by VT Industries.
 - 2. Performance Grade: WDMA I.S. 6A Heavy Duty.
 - 3. Architectural Woodwork Standards Grade: Custom.
 - 4. Finish: Transparent.
 - 5. Wood Species and Cut for Transparent Finish: White oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels.
 - 6. Door Construction for Transparent Finish:
 - a. Stile and Rail Construction: Veneered, structural composite lumber or veneered, edge- and end-glued clear lumber. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than 1/16 inch (1.6 mm) thick.
 - b. Raised-Panel Construction: Clear lumber; edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
 - c. Raised-Panel Construction: Edge-glued, clear lumber; glued to both sides of a wood-based panel product. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
 - d. Raised-Panel Construction: Veneered, wood-based panel product with mitered, raised rims made from matching clear lumber.
 - e. Raised-Panel Construction: Veneered, shaped, wood-based panel product with veneer conforming to raised-panel shape.
 - f. Flat-Panel Construction: Veneered, wood-based panel product.
 - 7. Stile and Rail Widths: Manufacturer's standard, but not less than the following:
 - a. Stiles, Top and Intermediate Rails: 5 inches (127 mm).
 - b. Bottom Rails: 12 inches (304.8 mm).
 - 8. Raised-Panel Thickness: Manufacturer's standard, but not less than 3/4 inch (19 mm).
 - 9. Flat-Panel Thickness: 5/8 inch (15.88 mm).
 - 10. Molding Profile (Sticking): Recessed square.
 - 11. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick, complying with Section 08 80 00 "Glazing."
 - 12. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S. 6A and grade specified.

2.4 INTERIOR FIRE-RATED STILE AND RAIL WOOD DOORS

- A. Interior Fire-Rated Stile and Rail Wood Doors: Fire-rated (60-minute rating) doors complying with AWI, AWMAC, and WI's Architectural Woodwork Standards and with other requirements specified.
 - 1. Basis-of-Design: E106 by VT Industries.
 - 2. Performance Grade: WDMA I.S. 6A Heavy Duty.
 - 3. Architectural Woodwork Standards Grade: Custom.
 - 4. Panel Designs: Indicate on Drawings. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
 - 5. Finish: Transparent.
 - 6. Wood Species and Cut for Transparent Finish: White oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels.
 - 7. Interior Fire-Rated Door Construction: 1-3/4-inch- (44-mm-) thick, edged and veneered mineral-core stiles and rails and 1-1/8-inch- (29-mm-) thick, veneered mineral-core raised panels.
 - 8. Edge Construction for Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 - a. At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 9. Stile and Rail Widths: Manufacturer's standard, but not less than the following:
 - a. Stiles, Top and Intermediate Rails: 5 inches (127 mm).
 - b. Bottom Rails: 12 inches (304.8 mm).
 - 10. Molding Profile (Sticking): Recessed square.

2.5 STILE AND RAIL WOOD DOOR FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:
 - 1. Clearances:
 - a. Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors.
 - b. Provide 1/2 inch (13 mm) from bottom of door to top of decorative floor finish or covering.
 - c. Where threshold is shown on Drawings or scheduled, provide not more than 3/8 inch (10 mm) from bottom of door to top of threshold.
 - d. Comply with NFPA 80 requirements for fire-rated doors.
 - 2. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
 - 3. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.
- B. Fabricate stile and rail wood doors in sizes indicated for field fitting.
- C. Factory machine doors for hardware that is not surface applied.
 - 1. Locate hardware to comply with DHI-WDHS-3.
 - 2. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 - 3. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
 - 4. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- D. Glazed Openings: Factory install glazing in doors, complying with Section 08 80 00 "Glazing." Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.

2.6 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
 - 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 2. Finish faces, all four edges, edges of cutouts, and mortises.
 - 3. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:

1. Architectural Woodwork Standards Grade: Custom.
2. Finish: Architectural Woodwork Standards System 11, Polyurethane, Catalyzed.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Open-grain finish.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hardware: For installation, see Section 08 71 00 "Door Hardware."
- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 1. Install fire-rated doors according to NFPA 80.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory- Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.2 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, section 5.2.
 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.3 ADJUSTING

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

END OF SECTION 08 14 33

SECTION 08 36 13 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sectional-door assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory.
- B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer's product data.
- C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
- B. Regulatory Requirements: Comply with provisions in the U.S. Department of Justice's "2010 ADA Standards for Accessible Design," the United States Access Board's "Architectural Barriers Act (ABA) Standards" 41 CFR, Appendix A to Subpart 101-19.6, "Uniform Federal Accessibility Standards," and ICC A117.1.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Provide sectional doors that comply with performance requirements specified without failure from defective manufacture, fabrication, installation, or other defects in construction.
- B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
 - 1. Design Wind Load: As indicated on Drawings.
 - 2. Testing: In accordance with ASTM E330/E330M or DASHA 108 for garage doors and complying with DASHA 108 acceptance criteria.
- C. Seismic Performance: Provide sectional doors that withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 - 1. Component Importance Factor: 1.0.

2.2 SECTIONAL-DOOR ASSEMBLY (Doors R101A & R101B – Type B)

- A. Steel Sectional Door: Provide sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.
 - 1. Basis-of-Design: AV300 AlumaView Doors with IECC Requirements Package by Raynor
- B. Operation Cycles: Door components and operators capable of operating for not less than 50,000 operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.
- C. Air Infiltration: Maximum rate of 0.24 cfm/sq. ft. (1.22 L/s per sq. m) when tested in accordance with ASTM E283 or DASMA 105.
- D. U-Value: 0.130 Btu/sq. ft. x h x deg F (0.738 W/sq. m x K).
- E. Aluminum Sections: ASTM B221 (ASTM B221M) extruded-aluminum stile and rail members of alloy and temper standard with manufacturer for type of use and finish indicated; in minimum thickness required to comply with requirements; with rail and stile dimensions and profiles indicated on Drawings; and with overlapped or interlocked weather- and pinch-resistant seal at meeting rails.
 - 1. Door-Section Thickness: 3 inches (51 mm).
 - 2. Section Reinforcing: Continuous horizontal and diagonal reinforcement as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.
 - a. Hardware Locations: Provide reinforcement for hardware attachment.
 - 3. Insulated Stiles and Rails: Fill stiles and rails manufacturer's standard polyurethane expanding foam.
 - 4. Glazed Panels: Manufacturer's standard, aluminum-framed section with glazing sealed with glazing tape and aluminum glazing bead. Glazing as follows:
 - a. Insulating Glass Units: Manufacturers' standard unit with tempered glass lites complying with ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 1 (clear), Quality-Q3.
 - 5. Solid Aluminum Panels: ASTM B209 (ASTM B209M), alloy and temper standard with manufacturer for use and finish indicated.
 - a. Description: 1/2-inch- (12.7-mm-) thick overall insulated panel composed of 0.050-inch (1.3-mm) aluminum interior and exterior panels with an extruded polystyrene (EPS) core.
 - b. Attachment to Frame: Sealed with glazing tape and aluminum glazing bead.
 - c. Aluminum Surface: Smooth.
 - 6. Provide solid aluminum panels in bottom row.
- F. Track: Manufacturer's standard, galvanized-steel, vertical-lift track system. Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides.
 - 1. Material: Galvanized steel, ASTM A653/A653M, minimum G60 (Z180) zinc coating.
 - 2. Size: As recommended in writing by manufacturer for door size, weight, track configuration and door clearances indicated on Drawings.
 - 3. Track Reinforcement and Supports: Provide galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device.
 - a. Vertical Track: Incline vertical track to ensure weathertight closure at jambs. Provide continuous angle attached to track and wall.
- G. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom top and jambs of door. Provide combination bottom weatherseal and sensor edge for bottom seal.
- H. Windows: Manufacturer's standard window units of shape and size and in locations indicated on Drawings. Set glazing in vinyl, rubber, or neoprene glazing channel. Provide removable stops of same material as door-section frames. Provide the following glazing:
 - 1. Insulating Glass Units: Manufacturer's standard.
- I. Hardware: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless steel, or other corrosion-resistant fasteners, to suit door type.
 - 1. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch (2.01-mm) nominal coated thickness at each end stile and at each intermediate stile, in accordance with manufacturer's written recommendations for door size.
 - a. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible.

2. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Match roller-tire diameter to track width.
 - a. Roller-Tire Material: Manufacturer's standard.
 3. Push/Pull Handles: Equip each door with galvanized-steel lifting handles on each side of door, finished to match door.
- J. Locking Device:
1. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - a. Lock Cylinders: Cylinders complying with Section 08 71 00 "Door Hardware" requirements.
 - b. Keying: Keyed to building keying system.
 - c. Keys: Three for each cylinder.
- K. Counterbalance Mechanism:
1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
 2. Cable Drums and Shaft for Doors: Cast-aluminum cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised.
 - a. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft.
 3. Cables: Galvanized-steel, multistrand, lifting cables.
 4. Cable Safety Device: Include a spring-loaded steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if lifting cable breaks.
 5. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
 6. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.
- L. Manual Door Operator:
1. Push-Up Operation: Lift handles and pull rope for raising and lowering doors located on inside and outside of bottom section; with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf (111 N).
- M. Metal Finish:
1. Factory Prime Steel Finish: Compatible with field-applied finish and in manufacturer's standard color.
 2. Anodized Aluminum Finish:
 - a. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1) Color: Black.
- 2.3 SECTIONAL-DOOR ASSEMBLY (Doors 113 – Type E)
- A. Steel Sectional Door: Provide sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.
1. Basis-of-Design: ThermaSeal TM175 Sectional Insulated Steel Door by Raynor Garage Doors
- B. Operation Cycles: Door components and operators capable of operating for not less than 100,000 operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.
- C. Air Infiltration: Maximum rate of 0.12 cfm/sq. ft. (0.61 L/s per sq. m) when tested in accordance with ASTM E283 or DASMA 105.
- D. U-Value: 0.052 Btu/sq. ft. x h x deg F (1.19 W/sq. m x K).
- E. Steel Door Sections: ASTM A653/A653M, zinc-coated (galvanized), cold-rolled, commercial steel sheet with G40 (Z120) zinc coating.
1. Door-Section Thickness: 1-3/4 inches (44 mm).
 2. Section Faces:
 - a. Thermal-Break Construction: Provide sections with continuous thermal-break construction separating the exterior and interior faces of door.

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c. Keys: Three for each cylinder.

K. Counterbalance Mechanism:

1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
2. Cable Drums and Shaft for Doors: Cast-aluminum cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised.
 - a. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft.
3. Cables: Galvanized-steel, multistrand, lifting cables.
4. Cable Safety Device: Include a spring-loaded steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if lifting cable breaks.
5. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
6. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

L. Manual Door Operator:

1. Push-Up Operation: Lift handles and pull rope for raising and lowering doors located on inside and outside of bottom section; with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf (111 N).

M. Metal Finish:

1. Factory Prime Steel Finish: Compatible with field-applied finish and in manufacturer's standard color.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer's written instructions.
- B. Tracks:
 1. Fasten vertical track assembly to opening jambs and framing with fasteners spaced not more than 24 inches (610 mm) apart.
 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
- C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.2 DEMONSTRATION

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

END OF SECTION 08 36 13

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SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Aluminum-framed storefront systems.
 - 2. Aluminum-framed entrance door systems.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For sealants, indicating VOC content.
 - 2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
 - 3. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 4. Environmental Product Declaration: For each product.
- C. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 2. Include point-to-point wiring diagrams.
- D. Samples: For each type of exposed finish required.
- E. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.
- F. Delegated Design Submittal: For aluminum-framed entrances and storefronts, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
- B. Product test reports.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M)

contractors and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

- B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by the International Accreditation Service or the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Owner and Architect.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 WARRANTY

- A. Special Warranty: Manufacturer and Installer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked-enamel, powder-coat, or organic finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m).
 - 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).

- a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
 1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
 1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).
- G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
 1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.38 Btu/sq. ft. x h x deg F (2.16 W/sq. m x K) as determined in accordance with NFRC 100.
 - b. Entrance Doors: U-factor of not more than 0.43 Btu/sq. ft. x h x deg F (2.48 W/sq. m x K) as determined in accordance with NFRC 100.
 2. Solar Heat-Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined in accordance with NFRC 200.
 - b. Entrance Doors: SHGC of not more than 0.25 as determined in accordance with NFRC 200.
 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa) when tested in accordance with ASTM E283.
 - b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. (5.08 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than 55 as determined in accordance with AAMA 1503.
 - b. Entrance Doors: CRF of not less than 63 as determined in accordance with AAMA 1503.
- H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 STOREFRONT SYSTEMS:

- 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. Arcadia, Inc.
 2. Kawneer North America, an Arconic company.
 3. Oldcastle BuildingEnvelope™.
 4. SAFTI FIRST Fire Rated Glazing Solutions.
 5. U.S. Aluminum; a brand of C.R. Laurence.
- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Exterior Framing Construction: Thermally broken.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Finish: Color anodic finish.
 4. Fabrication Method: Field-fabricated stick system.
 5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 6. Steel Reinforcement: As required by manufacturer.
- C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.3 ENTRANCE DOOR SYSTEMS

- 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. Arcadia, Inc.
 - 2. Kawneer North America, an Arconic company.
 - 3. Oldcastle BuildingEnvelope™.
 - 4. SAFTI FIRST Fire Rated Glazing Solutions.
 - 5. U.S. Aluminum; a brand of C.R. Laurence.
- B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
 - 1. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 - 2. Door Design: Medium stile; 3-1/2-inch (88.9-mm) nominal width.
 - 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.

2.4 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article for each entrance door, to comply with requirements in this Section.
 - 1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
 - 3. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf (67 N) to release the latch and not more than 30 lbf (133 N) to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.
 - b. Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.
- C. Designations: Requirements for design, grade, function, finish, quantity, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
 - 1. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- D. Pivot Hinges: BHMA A156.4, Grade 1.
 - 1. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.
- E. Butt Hinges: BHMA A156.1, Grade 1, radius corner.
 - 1. Nonremovable Pins: Provide setscrew in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.
 - 2. Exterior Hinges: Stainless steel, with stainless-steel pin.
 - 3. Quantities:
 - a. For doors up to 87 inches (2210 mm) high, provide three hinges per leaf.
 - b. For doors more than 87 and up to 120 inches (2210 and up to 3048 mm) high, provide four hinges per leaf.
- F. Continuous-Gear Hinges: BHMA A156.26.
- G. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.
- H. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305.

- I. Cylinders:
 - 1. As specified in Section 08 71 00 "Door Hardware."
 - 2. BHMA A156.5, Grade 1.
 - a. Keying: Master key system. Permanently inscribe each key with a visual key control number and include notation to be furnished by Owner.
 - J. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
 - K. Operating Trim: BHMA A156.6.
 - L. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.
 - M. Concealed Overhead Holders and Stops: BHMA A156.8, Grade 1.
 - N. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
 - O. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
 - 2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
 - P. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
 - Q. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (12.7 mm).
 - R. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.
- 2.5 GLAZING
- A. Glazing: Comply with Section 08 80 00 "Glazing."
 - B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
 - C. Glazing Sealants: As recommended by manufacturer.
 - 1. Verify sealant has a VOC content of 250 g/L or less.
- 2.6 MATERIALS
- A. Sheet and Plate: ASTM B209 (ASTM B209M).
 - B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).
 - C. Structural Profiles: ASTM B308/B308M.
 - D. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
 - E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

- F. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- G. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
- F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
- G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- H. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.8 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1. Color: Black.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.

2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
 - H. Set continuous sill members and flashing in full sealant bed, as specified in Section 07 92 00 "Joint Sealants," to produce weathertight installation.
 - I. Install joint filler behind sealant as recommended by sealant manufacturer.
 - J. Install components plumb and true in alignment with established lines and grades.
- 3.2 INSTALLATION OF GLAZING
- A. Install glazing as specified in Section 08 80 00 "Glazing."
- 3.3 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS
- A. Install entrance doors to produce smooth operation and tight fit at contact points.
 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- 3.4 FIELD QUALITY CONTROL
- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of two tests in areas as directed by Architect.
 2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Perform a minimum of two tests in areas as directed by Architect.
 3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
 - C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
 - D. Prepare test and inspection reports.

END OF SECTION 08 41 13

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SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware for:
 - a. Swinging doors.
2. Electronic access control system components

B. Section excludes:

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

C. Related Sections:

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

1.02 REFERENCES

A. UL - Underwriters Laboratories

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

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
2. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
 - a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
 - b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
 - a. Wiring Diagrams: For power, signal, and control wiring and including:
 - 1) Details of interface of electrified door hardware and building safety and security systems.
 - 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
4. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect's hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each hardware set cross-referenced to indications on Drawings.
 - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.

- 7) Mounting locations for hardware.
- 8) Door and frame sizes and materials.
- 9) Degree of door swing and handing.
- 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.

5. Key Schedule:

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

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Factory order acknowledgement numbers (for warranty and service)
 - d. Name, address, and phone number of local representative for each manufacturer.
 - e. Parts list for each product.
 - f. Final approved hardware schedule edited to reflect conditions as-installed.
 - g. Final keying schedule
 - h. Copies of floor plans with keying nomenclature
 - i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
 - j. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

1. Submit a written report of the results of functional testing and inspection for fire door assemblies, in compliance with NFPA 80.
 - a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
 - b. Report to include the door number for each fire door assembly, door location, door and frame material, fire rating, and summary of deficiencies.
2. Submit a written report of the results of functional testing and inspection for required egress door assemblies, in compliance with NFPA 101.

- a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
- b. Report to include the door number for each required egress door assembly, door location, door and frame material, fire rating, and summary of deficiencies.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
 - a. Warehousing Facilities: In Project's vicinity.
 - b. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 - c. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
 - d. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
 - 1) Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.
 - c. Can inspect and verify components are in working order upon completion of installation.
 - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
3. Electrified Door Hardware
 - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

4. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article, herein for door hardware on doors in an accessible route.
- C. Pre-Installation Meetings
 1. Keying Conference
 - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.
 - 3) Requirements for key control system.
 - 4) Requirements for access control.
 - 5) Address for delivery of keys.
 2. Pre-installation Conference
 - a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Inspect and discuss preparatory work performed by other trades.
 - c. Inspect and discuss electrical roughing-in for electrified door hardware.
 - d. Review sequence of operation for each type of electrified door hardware.
 - e. Review required testing, inspecting, and certifying procedures.
 - f. Review questions or concerns related to proper installation and adjustment of door hardware.
 3. Electrified Hardware Coordination Conference:
 - a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.

- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.07 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
 - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - a) 10 year
 - 2) Closers
 - a) 30 year
 - 3) Automatic Operators
 - a) 2 year
 - 4) Accessories
 - a) Ives Continuous Hinges: Lifetime

1.08 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- B. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Ives 5BB series
2. Acceptable Manufacturers and Products:
 - a. McKinney TA/T4A series
 - b. Stanley FBB Series.

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
5. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
9. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
10. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.03 CONTINUOUS HINGES

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Select
 - b. Stanley
 - c. McKinney

B. Requirements:

1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware.
7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.04 MORTISE LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Sargent 8200 series
2. Acceptable Manufacturers and Products:
 - a. Schlage L series
 - b. Falcon MA series

B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3 hour fire doors.
2. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
3. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
4. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless steel.
5. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
6. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide a request to exit (RX) switch that is actuated with rotation of inside lever.
7. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Lever Design: Sargent L.

2.05 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Sargent 10 line
2. Acceptable Manufacturers and Products:
 - a. Schlage ND series
 - b. Falcon T series

B. Requirements:

1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3 hour fire doors.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Provide electrified options as scheduled in the hardware sets.
8. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.

a. Lever Design: Sargent L.

2.06 DEADBOLTS:

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Sargent 480 Series
2. Acceptable Manufacturers and Products:
 - a. Schlage B600 Series
 - b. Falcon D100 series

B. Requirements:

1. Provide deadbolt series conforming to ANSI/BHMA A156.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide deadbolts with standard 2-3/4 inches (70 mm) backset. Provide 2-3/8 inches (60 mm) where noted or if door or frame detail requires. Provide deadbolt with full 1-inch (25 mm) throw, constructed of steel alloy.
4. Provide manufacturer's standard strike.

2.07 ELECTRIC STRIKES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Von Duprin 6000 Series.
2. Acceptable Manufacturers and Products:
 - a. Folger Adam 300 Series
 - b. HES 1006 Series

B. Requirements:

1. Provide electric strikes designed for use with type of locks shown at each opening.
2. Provide electric strikes UL Listed as burglary-resistant.
3. Where required, provide electric strikes UL Listed for fire doors and frames.
4. Provide transformers and rectifiers for each strike as required. Verify voltage with electrical contractor.

2.08 CYLINDERS

A. Manufacturers:

1. Scheduled Manufacturer and Product:

- a. Schlage
- 2. Acceptable Manufacturers and Products:
 - a. No Substitute
- B. Requirements:
 - 1. Provide cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.
 - 2. Provide the following keyway: Schlage C
- C. Construction Keying:
 - 1. Replaceable Construction Cores.
 - a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - 1) 12 construction change (day) keys.
 - b. Secure the exterior doors with temporary cylinders.

2.09 KEYING

- A. Provide cylinders/cores keyed into Owner's existing keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference. Contact:
- B. Requirements:
 - 1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - a. Master Keying system as directed by the Owner.
 - 2. Forward biting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 - 3. Provide keys with the following features:
 - a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - b. Patent Protection: Keys and blanks protected by one or more utility patent(s)
 - 4. Quantity: Furnish in the following quantities.
 - a. Change (Day) Keys: 3 per cylinder/core.
 - b. Master Keys: 6.

2.10 KEY CONTROL SYSTEM

- A. Manufacturers:
 - 1. Scheduled Manufacturer:
 - a. Telkee
 - 2. Acceptable Manufacturers:
 - a. HPC
 - b. Lund
- B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 - b. Provide hinged-panel type cabinet for wall mounting.

2.11 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Sargent 351 series
2. Acceptable Manufacturers and Products:
 - a. LCN 4050 series
 - b. Falcon SC70A series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
3. Closer Body: 1-1/2 inch (38 mm) diameter with 5/8 inch (16 mm) diameter heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.12 ELECTRO-HYDRAULIC AUTOMATIC OPERATORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. LCN 4600 series
2. Acceptable Manufacturers and Products:
 - a. Norton 6000 series
 - b. Besam Power Swing

B. Requirements:

1. Provide low energy automatic operator units with hydraulic closer complying with ANSI/BHMA A156.19.
2. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
3. Provide units with conventional door closer opening and closing forces unless power operator motor is activated. Provide door closer assembly with adjustable spring size, back-check, and opening and closing speed adjustment valves to control door

4. Provide units with on/off switch for manual operation, motor start up delay, vestibule interface delay, electric lock delay, and door hold open delay.
5. Provide drop plates, brackets, and adapters for arms as required for details.
6. Provide hard-wired actuator switches and receivers for operation as specified.
7. Provide weather-resistant actuators at exterior applications.
8. Provide key switches with LED's, recommended and approved by manufacturer of automatic operator as required for function described in operation description of hardware group below. Cylinders: Refer to "KEYING" article, herein.
9. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.
10. Provide units with vestibule inputs that allow sequencing operation of two units, and SPDT relay for interfacing with latching or locking devices.

2.13 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives.
2. Acceptable Manufacturers:
 - a. Trimco
 - b. Burns
 - c. Rockwood.

B. Requirements:

1. Provide push plates, push bars, pull plates, and pulls with diameter and length as scheduled.

2.14 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Burns
 - b. Trimco
 - c. Rockwood

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.15 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:

- a. Glynn-Johnson
- 2. Acceptable Manufacturers:
 - a. Rixson
 - b. Sargent
 - c. ABH
- B. Requirements:
 - 1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
 - 2. Provide friction type at doors without closer and positive type at doors with closer.

2.16 DOOR STOPS AND HOLDERS

- A. Manufacturers:
 - 1. Scheduled Manufacturer:
 - a. Ives
 - 2. Acceptable Manufacturers:
 - a. Trimco
 - b. Burns
 - c. Rockwood
- B. Provide door stops at each door leaf:
 - 1. Provide wall stops wherever possible. Provide concave type where lockset has a push button or thumbturn.
 - 2. Where a wall stop cannot be used, provide universal floor stops.
 - 3. Where wall or floor stop cannot be used, provide overhead stop.
 - 4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.17 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

- A. Manufacturers:
 - 1. Scheduled Manufacturer:
 - a. Zero International
 - 2. Acceptable Manufacturers:
 - a. National Guard
 - b. Reese
 - c. Pemko
- B. Requirements:
 - 1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
 - 2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - 3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
 - 4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.18 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives
2. Acceptable Manufacturers:
 - a. Burns
 - b. Rockwood

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.19 DOOR POSITION SWITCHES

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Schlage
2. Acceptable Manufacturers:
 - a. GE-Interlogix
 - b. Sargent

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.20 FINISHES

A. Finish: BHMA 626/652 (US26D); except:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Continuous Hinges: BHMA 630 (US32D)
3. Continuous Hinges: BHMA 628 (US28)
4. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
5. Protection Plates: BHMA 630 (US32D)
6. Overhead Stops and Holders: BHMA 630 (US32D)
7. Door Closers: Powder Coat to Match
8. Wall Stops: BHMA 630 (US32D)
9. Latch Protectors: BHMA 630 (US32D)
10. Weatherstripping: Clear Anodized Aluminum
11. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.
- C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- D. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Where on-site modification of doors and frames is required:
 - 1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
 - 2. Field modify and prepare existing doors and frames for new hardware being installed.
 - 3. When modifications are exposed to view, use concealed fasteners, when possible.
 - 4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:
 - a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
 - b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
 - c. Doors in rated assemblies: NFPA 80 for restrictions on on-site door hardware preparation.

3.03 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
 - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- H. Lock Cylinders:
 - 1. Install construction cores to secure building and areas during construction period.
 - 2. Replace construction cores with permanent cores as indicated in keying section.
- I. Wiring: Coordinate with Division 26, ELECTRICAL sections for:
 - 1. Conduit, junction boxes and wire pulls.
 - 2. Connections to and from power supplies to electrified hardware.
 - 3. Connections to fire/smoke alarm system and smoke evacuation system.
 - 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
 - 5. Testing and labeling wires with Architect's opening number.
- J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- L. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- M. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- N. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- O. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- P. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- Q. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- R. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.04 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 to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.05 CLEANING AND PROTECTION

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

3.06 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

HW SET: 01

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	~ 630	VON
1	EA	CLOSER	351 UO	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	381A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
1	EA	DOOR CONTACT	679-05HM	~ BLK	SCE
1	EA	REX	BY SECURITY CONTRACTOR	~	
1	EA	LOW VOLTAGE POWER	BY SECURITY CONTRACTOR	~	

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER TO TEMPORARILY RELEASE THE ELECTRIC STRIKE, USER OPENS DOOR TO ENTER. DOOR POSITION IS MONITORED THROUGH ACCESS CONTROL SYSTEM. EGRESS AT ALL TIMES BY INSIDE LEVER.

HW SET: 02

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
1	EA	CLOSER	351 P10	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS18S	BLK	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

HW SET: 03

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
1	EA	CLOSER	351 UO	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS18S	BLK	IVE
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	381A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

HW SET: 04

Each to have:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	CLASSROOM DEADBOLT	SC-487	626	SAR
1	EA	PUSH PLATE	8200 8" X 16"	630	IVE
1	EA	PULL PLATE	8305 8" 4" X 16"	630	IVE
1	EA	CLOSER	351 CPS	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER
			VFY SILL COND.		

HW SET: 05

Each to have:

6	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2	626	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
2	EA	OH STOP & HOLDER	90H	630	GLY
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	GASKETING	429AA-S	AA	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	ASTRAGAL	43SP	SP	ZER
1	EA	THRESHOLD	655A-223	A	ZER

HW SET: 06

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	~ 630	VON
1	EA	CLOSER	351 UO	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
1	EA	DOOR CONTACT	679-05HM	~ BLK	SCE
1	EA	REX	BY SECURITY CONTRACTOR	~	
1	EA	LOW VOLTAGE POWER	BY SECURITY CONTRACTOR	~	

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER TO TEMPORARILY RELEASE THE ELECTRIC STRIKE, USER OPENS DOOR TO ENTER. DOOR POSITION IS MONITORED THROUGH ACCESS CONTROL SYSTEM. EGRESS AT ALL TIMES BY INSIDE LEVER.

HW SET: 07

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
1	EA	CLOSER	351 UO	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HW SET: 08

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
1	EA	CLOSER	351 UO	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	SILENCER	SR64	GRY	IVE

HW SET: 09

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	SC-FW-28-10G04 LL	626	SAR
1	EA	OH STOP	450S	630	GLY
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	SILENCER	SR64	GRY	IVE

HW SET: 10

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE LOCK	SC-28-10G05 LL	626	SAR
1	EA	CLOSER	351 UO	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	SILENCER	SR64	GRY	IVE

HW SET: 11

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	PRIVACY W/ IND	V20-8265 LNL	626	SAR
1	EA	CLOSER	351 UO	689	SAR
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HW SET: AL-01

Each to have:

1	EA	CONT. HINGE	112XY	628	IVE
1	EA	DEADLATCH	4900	628	ADA
1	EA	DEADLATCH PADDLE	4591	628	ADA
1	EA	MORTISE CYLINDER	26-072 X L583-446 118	626	SCH
1	EA	ELECTRIC STRIKE	6211AL FSE 12/16/24/28 VAC/VDC	~ 630	VON
1	EA	PUSH/PULL BAR	9190EZHD-10"-NS	630	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURF. AUTO OPERATOR	4642 TBWMS 120 VAC	~ 689	LCN
1	EA	WEATHER RING	8310-801	PLA	LCN
2	EA	ACTUATOR, WALL MOUNT	8310-853	~ 630	LCN
1	EA	FLUSH MOUNT BOX	8310-867F	~ 689	LCN
1	EA	SURFACE MOUNT BOX	8310-867S	~ 689	LCN
1	SET	PERIMETER GASKET	BY DOOR MANUFACTURER		
1	EA	DOOR SWEEP	BY DOOR MANUFACTURER		
1	EA	THRESHOLD	BY DOOR MANUFACTURER		
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
1	EA	DOOR CONTACT	679-05HM	~ BLK	SCE
1	EA	REX	BY SECURITY CONTRACTOR	~	
1	EA	LOW VOLTAGE POWER	BY SECURITY CONTRACTOR	~	

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER TO TEMPORARILY RELEASE THE ELECTRIC STRIKE, USER OPENS DOOR TO ENTER. PRESSING OUTSIDE ACTUATOR WHEN STRIKE IS UNLOCKED CYCLES THE OPERATOR, PRESSING INTERIOR ACTUATOR TEMPORARILY UNLOCKS THE STRIKE AND CYCLES THE OPERATOR. OUTSIDE ACTUATOR IS ACTIVE WHEN STRIKE IS UNLOCKED, INSIDE ACTUATOR ALWAYS ACTIVE. DOOR POSITION IS MONITORED THROUGH ACCESS CONTROL SYSTEM. REX BY MOTION SENSOR, EGRESS AT ALL TIMES BY INSIDE LEVER. ACCESS CONTROL MAY BE PROGRAMMED TO REMAIN UNLOCKED FOR EXTENDED TIME.

HW SET: AL-02

Each to have:

1	EA	CONT. HINGE	112XY	628	IVE
1	EA	DEADLATCH	4900	628	ADA
1	EA	DEADLATCH PADDLE	4591	628	ADA
1	EA	MORTISE CYLINDER	26-072 X L583-446 118	626	SCH
1	EA	ELECTRIC STRIKE	6211AL FSE 12/16/24/28 VAC/VDC	~ 630	VON
1	EA	PUSH/PULL BAR	9190EZHD-10"-NS	630	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURF. AUTO OPERATOR	4631 120 VAC	~ 689	LCN
1	EA	WEATHER RING	8310-801	PLA	LCN
1	EA	ACTUATOR, JAMB MOUNT	8310-818	~ 630	LCN
1	EA	MOUNT BOX	8310-819F		LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853	~ 630	LCN
1	EA	SURFACE MOUNT BOX	8310-867S	~ 689	LCN
1	SET	PERIMETER GASKET	BY DOOR MANUFACTURER		
1	EA	DOOR SWEEP	BY DOOR MANUFACTURER		
1	EA	THRESHOLD	BY DOOR MANUFACTURER		
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
1	EA	DOOR CONTACT	679-05HM	~ BLK	SCE
1	EA	REX	BY SECURITY CONTRACTOR	~	
1	EA	LOW VOLTAGE POWER	BY SECURITY CONTRACTOR	~	

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER TO TEMPORARILY RELEASE THE ELECTRIC STRIKE, USER OPENS DOOR TO ENTER. PRESSING OUTSIDE ACTUATOR WHEN STRIKE IS UNLOCKED CYCLES THE OPERATOR, PRESSING INTERIOR ACTUATOR TEMPORARILY UNLOCKS THE STRIKE AND CYCLES THE OPERATOR. OUTSIDE ACTUATOR IS ACTIVE WHEN STRIKE IS UNLOCKED, INSIDE ACTUATOR ALWAYS ACTIVE. DOOR POSITION IS MONITORED THROUGH ACCESS CONTROL SYSTEM. REX BY MOTION SENSOR, EGRESS AT ALL TIMES BY INSIDE LEVER. ACCESS CONTROL MAY BE PROGRAMMED TO REMAIN UNLOCKED FOR EXTENDED TIME.

HW SET: RU-01

Each to have:

EA NOTE

ALL HARDWARE BY DOOR
SUPPLIER/MANUFACTURER

END OF SECTION 08 71 00

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SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glass products.
 - 2. Insulating glass.
 - 3. Glazing sealants.
 - 4. Glazing tapes.
 - 5. Miscellaneous glazing materials.

1.2 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
- C. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass.
- B. Product test reports.
- C. Preconstruction adhesion and compatibility test report.
- D. Sample warranties.

1.5 QUALITY ASSURANCE

- A. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.6 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: Five years from date of Substantial Completion.

- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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. AGC Glass Company North America, Inc.
 2. Cardinal Glass Industries.
 3. Guardian Glass; SunGuard.
 4. Oldcastle BuildingEnvelope™.
 5. Pilkington North America.
 6. Vetrotech Saint-Gobain.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazing.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
1. Design Wind Pressures: As indicated on Drawings.
 2. Design Snow Loads: As indicated on Drawings.
 3. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.
- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
 3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.
- E. Acoustic Performance:
1. Exterior Glazing: 33 OITC.
 2. Interior Glazing: 37 STC.

2.3 GLASS PRODUCTS, GENERAL

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

- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- C. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.
- D. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.
- E. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 - 2. Perimeter Spacer: Manufacturer's standard spacer material and construction.

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.
- B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dow Corning Corporation.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - d. Sika Corporation.
 - e. Tremco Incorporated.
- C. Neutral-Curing Silicone Glazing Sealant, Class 50: Complying with ASTM C920, Type S, Grade NS, Use NT.
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BASF Corporation.
 - b. Dow Corning Corporation.
 - c. GE Construction Sealants; Momentive Performance Materials Inc.
 - d. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - e. Sika Corporation.
 - f. Tremco Incorporated.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks:
 - 1. Silicone with Shore A durometer hardness of 85, plus or minus 5.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- C. Spacers:
 - 1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- D. Edge Blocks:
 - 1. Silicone with Shore A durometer hardness per manufacturer's written instructions.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- E. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

3.2 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Apply heel bead of elastomeric sealant.
- F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.6 MONOLITHIC GLASS SCHEDULE

- A. Clear Glass Type: Fully tempered float glass.
1. Minimum Thickness: 6 mm.
 2. Safety glazing required where indicated on the Drawings.
- B. Ceramic-Coated Spandrel Glass Type: Fully tempered float glass.
1. Glass: Tinted float glass.
 2. Tint Color: Gray.
 3. Coating Color: As selected by Architect from manufacturer's full range.
 4. Minimum Thickness: 6 mm.
 5. Coating Location: Second surface.

3.7 INSULATING GLASS SCHEDULE

- A. Low-E-Coated, Tinted Insulating Glass Type:
1. Overall Unit Thickness: 1 inch (25 mm).
 2. Minimum Thickness of Each Glass Lite: 6 mm.
 3. Outdoor Lite: Tinted annealed or Fully tempered float glass, as indicated on the Drawings.
 4. Interspace Content: Air.
 5. Indoor Lite: Clear annealed or Fully tempered float glass, as indicated on the Drawings.
 6. Low-E Coating: Pyrolytic or sputtered on second or third surface.
 7. Safety glazing required, where indicated on the Drawings.
- B. Ceramic-Coated, Low-E, Insulating Spandrel Glass Type:
1. Coating Color: As selected by Architect from manufacturer's full range.
 2. Overall Unit Thickness: 1 inch (25 mm).
 3. Minimum Thickness of Each Glass Lite: 6 mm.
 4. Outdoor Lite: Clear fully tempered float glass.
 5. Interspace Content: Air.
 6. Indoor Lite: Clear fully tempered float glass.
 7. Low-E Coating: Pyrolytic or sputtered on second or third surface.
 8. Opaque Coating Location: Fourth surface.

END OF SECTION 08 80 00

SECTION 08 83 00 - MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Silvered flat glass mirrors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Product Data: For adhesives, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.
- D. Samples: For each type of the following:
 - 1. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
 - 2. Mirror Clips: Full size.
 - 3. Mirror Trim: 12 inches (300 mm) long.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified Installer, who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.6 PRECONSTRUCTION TESTING

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Guardian Glass; SunGuard.
 - 2. National Glass Industries.
 - 3. Trulite Glass & Aluminum Solutions, LLC.
 - 4. Walker Glass Co., Ltd.

2.2 SILVERED FLAT GLASS MIRRORS

- A. Mirrors, General: ASTM C1503; manufactured using copper-free, low-lead mirror coating process.
- B. Tempered Glass Mirrors: Mirror Glazing Quality for blemish requirements and complying with ASTM C1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
 - 1. Nominal Thickness: 4.0 mm.

2.3 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors.
 - 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. Laurence, C. R. Co., Inc.
 - b. Liquid Nails Adhesive.
 - c. Macco Adhesives.
 - d. Pecora Corporation.
 - 2. Verify adhesives have a VOC content of 70 g/L or less.
- D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.4 MIRROR HARDWARE

- A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
 - 1. Aluminum J Channel Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch (9.5 and 22 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm).
 - 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) Andscot Company, Inc.
 - 2) Laurence, C. R. Co., Inc.
 - 3) Stylmark, Inc.
 - 2. Finish: Clear bright anodized.
- B. Mirror Top Clips: Two (2) CRL Round Mirror Clips or equal.
- C. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

2.5 FABRICATION

- A. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.
- B. Mirror Edge Treatment: Flat polished.
 - 1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
- C. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Install mirrors with mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 - 1. Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
- C. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION 08 83 00

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SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation reports for firestop tracks, post-installed anchors and power-actuated fasteners.

1.4 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
 - 2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- C. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
 - 1. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
 - 2. Depth: As indicated on Drawings.
- D. Slip-Type Head Joints: Where indicated, provide one of the following:
 - 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 2-inch (51-mm) minimum vertical movement.

2. Single Long-Leg Track System: ASTM C645 top track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
 3. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Steel Thickness: 0.0296 inch (0.752 mm).
- G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: 1-1/2 inches (38 mm).
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C645.
1. Minimum Base-Steel Thickness: 0.0296 inch (0.752 mm).
 2. Depth: 7/8 inch (22.2 mm).
- I. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
1. Configuration: Asymmetrical or hat shaped.
- J. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: 3/4 inch (19 mm).
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-steel thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- C. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.
- D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: 2 inches (51 mm).
- E. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 2. Steel Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
 - a. Minimum Base-Steel Thickness: 0.0269 inch (0.683 mm).
 - b. Depth: As indicated on Drawings.
 3. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch (22 mm) deep.

- a. Minimum Base-Steel Thickness: 0.0296 inch (0.752 mm).
- 4. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical or hat shaped.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.
- E. Direct Furring:
1. Screw to wood framing.
 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- F. Z-Shaped Furring Members:
1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches (610 mm) o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.3 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, 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 attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16

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SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Exterior gypsum board for ceilings and soffits.
 - 3. Tile backing panels.
 - 4. Texture finishes.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Gypsum board, Type X.
 - 2. Glass-mat, water-resistant backing board.
 - 3. Interior trim.
 - 4. Joint treatment materials.
 - 5. Sound-attenuation blankets.
 - 6. Textured finishes.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content of required elements.
 - 2. [Product Data](#): For adhesives and sealants, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
- C. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. [Recycled Content](#): Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent.
- B. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.
 - 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. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. PABCO Gypsum.
 - f. USG Corporation.
 - 2. Thickness: 5/8 inch (15.9 mm).

3. Long Edges: Tapered.

2.4 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
 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. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 2. Core: 5/8 inch (15.9 mm), Type X.
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 2. Shapes:
 - a. Cornerbead.
 - b. Expansion (control) joint.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Exterior Gypsum Soffit Board: Paper.
 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.7 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 1. Verify adhesives have a VOC content of 50 g/L or less.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

E. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."

2.8 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

B. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.

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. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
2. Texture: Holy Smooth.

PART 3 - EXECUTION

3.1 INSTALLATION AND FINISHING OF PANELS

- A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- B. Comply with ASTM C840.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. 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.
- E. Prefill open joints and damaged surface areas.
- F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 2. Level 2: Panels that are substrate for tile.
 3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
- H. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

3.2 APPLYING TEXTURE FINISHES

- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
- B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture matching approved mockup and free of starved spots or other evidence of thin application or of application patterns.

3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 09 29 00

SECTION 09 30 13 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glazed wall tile.
 - 2. Waterproof membranes.
 - 3. Crack isolation membranes.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Samples:
 - 1. Each type and composition of tile and for each color and finish required.
 - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a Five-Star member of the National Tile Contractors Association.
 - 2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of wall tile installation.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

- A. Glazed Wall Tile Type:
 - 1. Basis-of-Design: Crossville, Swatches
 - 2. Module Size: 3 by 12 inches (73 by 298 mm).
 - 3. Face Size Variation: Rectified.
 - 4. Thickness: 5/16 inch (8 mm).
 - 5. Face: Pattern of design indicated, with manufacturer's standard edges.
 - 6. Finish: Bright, opaque glaze.
 - 7. Tile Color and Pattern: As selected by Architect from manufacturer's full range.
 - 8. Grout Color: As selected by Architect from manufacturer's full range.
 - 9. Mounting:
 - a. Factory, back mounted.
 - b. PregROUTED sheets of tiles are factory assembled and grouted with manufacturer's standard white silicone rubber.
 - 10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base: Coved, module size 4 by 8 inches (101.6 by 203.2 mm).
 - b. Wainscot Cap: Surface bullnose, module size 3 by 12 inches (73 by 298 mm).
 - c. External Corners: Surface bullnose, same size as adjoining flat tile.
 - d. Internal Corners: Field-buttet square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

2.3 SETTING MATERIALS

- A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
 - 1. Provide prepackaged, dry-mortar mix to which only water must be added at Project site.
 - 2. For wall applications, provide nonsagging mortar.

2.4 GROUT MATERIALS

- A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.

2.5 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Glazed Wall Tile: 1/16 inch (1.6 mm).
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.4 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. TCNA W245 or TCNA W248: Thinset mortar on glass-mat, water-resistant gypsum backer board.
 - a. Thinset Mortar: Modified dry-set mortar.
 - b. Grout: Water-cleanable epoxy grout.

END OF SECTION 09 30 13

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SECTION 09 30 23 - GLASS TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glass tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
- C. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- D. Samples:
 - 1. Each type and composition of tile and for each color and finish required.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a Five-Star member of the National Tile Contractors Association.

1.6 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Glass Tile Standard: Provide Standard grade glass tile that complies with ANSI A137.2 for types and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

- A. Large-Format Glass-Tile Type:
 - 1. Basis-of-Design: Color Wave by Daltile
 - 2. Face Size: 3 by 6 inches (76 by 152 mm).
 - 3. Sizing Category: Standard.
 - 4. Tile Color and Pattern: As selected by Architect from manufacturer's full range.
 - 5. Grout Color: As selected by Architect from manufacturer's full range.

2.3 SETTING MATERIALS

- A. Modified Dry-Set Mortar (Thinset): ANSI A118.4; white, unless otherwise indicated.
 - 1. Provide prepackaged, dry-mortar mix to which only water must be added at Project site.
 - 2. For wall applications, provide nonsagging mortar.
- B. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.
 - 1. Verify adhesives have a VOC content of 65 g/L or less.

2.4 GROUT MATERIALS

- A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L.

2.5 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
- B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Large-Format Glass Tile: 1/16 inch (1.6 mm).
- G. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- H. Grout Sealer: Apply grout sealer to grout joints in accordance with grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.
- I. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.4 INTERIOR GLASS TILE INSTALLATION SCHEDULE

- A. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. TCNA W245 or TCNA W248: Thinset mortar on glass-mat, water-resistant gypsum backer board.
 - a. Thinset Mortar: Modified dry-set mortar.
 - b. Grout: Water-cleanable epoxy grout.

END OF SECTION 09 30 23

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SECTION 09 65 00 – RESILIENT ATHLETIC SURFACING

PART ONE – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Resilient athletic surfacing.

1.2 QUALITY ASSURANCE

- A. Floor System Manufacturer Qualifications.
 - 1. Manufacturer shall be an established firm experienced in field and have been in business for a minimum of ten (10) years.
- B. Floor Contractor / Installer Qualifications.
 - 1. Flooring contractor shall be experienced in the flooring field and approved by the manufacturer.
 - 2. Flooring contractor shall be proficient in installing this type of rubber flooring and have completed at least three projects of similar magnitude and complexity.

1.3 SUBMITTALS

- A. Submit duplicate 300 mm x 300 mm (12 in x 12 in) sample pieces of flooring material.
- B. Submit layout drawing of flooring tiles to Architect for review prior to starting any work.

1.4 CLOSEOUT SUBMITTALS

- A. Provide maintenance data for resilient athletic surfacing for incorporation into manual.

1.5 EXTRA MATERIALS

- A. Provide extra materials of resilient athletic surfacing and adhesives.
- B. Provide 3% of each color, of flooring material required for project for maintenance use.
- C. Extra materials to be in one piece and from same production run as installed materials.
- D. Clearly identify each type of flooring and each container of adhesive.
- E. Deliver to Owner, upon completion of the work of this section.
- F. Store where directed by Owner.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver resilient athletic surfacing materials undamaged with manufacturer's labels intact.
- B. Store in a protected area on site a minimum of 48 hours prior to installation in order to acclimatize to room conditions. (Extreme cold or hot climate may require additional time.)
- C. Store flat, blocked off floor.
- D. Prevent damage or contamination to from water, moisture, freezing, excessive heat, direct sunlight and construction dust or dirt.
- E. Protect from construction activities. Provide tarpaulins or plastic coverings blocked to allow ventilation and prevent contamination from dust or debris.
- F. Inspect for damage, color consistency, and conformity to specification prior to installation, notify the appropriate authority of any imperfections or irregularities, and do not proceed with installation if irregularities exist.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install when the moisture vapor emission rate (MVER) exceeds 2.27 kg per 92.9 m² (5 lbs per 1,000 sq.ft) per 24 hours, when using the anhydrous calcium chloride test (ASTM F1869).
- B. Do not install when the relative humidity of concrete slabs exceeds 75% (ASTM F2170).
- C. Use only when the substrate temperature is between 10°C and 32°C (50°F and 90°F), and when the ambient relative humidity is below 65%.

1.8 Warranty

- A. Supply manufacturer's standard limited warranty against defects in materials or workmanship for 5 years prorated in Ice Arenas from date of sale with the Original Purchaser.
- B. Warranty is void if solvent based adhesive is used for the installation of resilient athletic surfacing.
- C. Warranty is void if damaged or irregular materials have been installed without prior notification and adjustments made by manufacturer.

PART TWO – PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Solid Colored with Marbleized Pattern Rubber Flooring Tile, Square.

1. Construction: two-layer calendared and vulcanized rubber.
2. Top Layer: colored virgin blend rubber.
3. Bottom Layer: 55% recycled rubber.
4. Size: 8 by 48 inches $\pm \frac{1}{32}$ in (203.2 by 1219.2 mm ± 0.8 mm).
5. Pattern: Woodgrain.
6. Finish: matte.
7. Thickness: 10mm (3/8 in) ± 0.4 mm ($\pm \frac{1}{64}$ in) tolerance.
8. Color: as selected by Architect from full line.
9. Material Properties:

Hardness Shore A	ASTM D2240	80 ± 5 /Bottom 72
Co-efficient of Friction	ASTM D2047	> 0.8 Dry
Compression Set	ASTM D395	0.0993
Static Coefficient of Friction	ASTM C-1028	> 1.0 Wet/Dry
Critical Radiant Flux	ASTM E648-03, NFPA253	Class I > .45 watts/cm ²
Static Load Limit	ASTM F970-00	<0.005 in @ 250 psi
Resistance to Heat	ASTM F-1514	Avg. 1.92 Passes
Tear Resistance	ASTM D-624	120.8 lbs / in
Moisture Absorption	ASTM D570	0.0037
Resistance to Chemicals	ASTM F-925	Passes
Wear Layer Thickness	ASTM F-410	> 0.050 Passes [2mm]
Abrasion Resistance	ASTM D-3389	< 0.15 gram Passes
Tensile Strength	ASTM D412	Top 1596.4 psi, Bottom 380.4 psi
Elongation at Break	ASTM D412	Top 334.3 / Bot 139.6
Dimensional Stability	ASTM F-2199	Avg. 0.08 Passes
Thickness	ASTM F-3868	Avg. .002 Passes
Size	ASTM F-2055	Avg. .002 Passes
Squareness	ASTM F-2055	Avg. .003 Passes
Quality of Cut	ASTM F-511	Avg. .002 Passes
VOC Compliance	CA 01350	Yes
Color Stability		Good
Light Reflection		Average
Contributes to LEED Points		Yes
Anti-microbial/Anti-fungal Properties	ASTM G21-90	Yes

10. Basis-of-Design: ProXL Woodgrain Collection as manufactured by North West Rubber Ltd., 33850 Industrial Avenue, Abbotsford, BC. Canada. Distributed by Becker Arena Products, Shakopee, MN. USA. 1-800-234-5522. info@beckerarena.com

B. Beveled Edging: Black rubber or vinyl transition ramp edging as available from flooring manufacturer.

C. Adhesive: SportFloor® 1 or 2-part, Urethane Adhesive, solvent free as recommended by manufacturer. (Do not use solvent based adhesives.)

PART THREE – EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

- A. Installation of resilient athletic surfacing should not begin until the work of all other trades has been completed, especially overhead trades.
- B. Examine floor areas to be covered and report any deficiencies to the Contractor. Do not proceed with installation until substrates and conditions comply with manufacturer's requirements for installation.
- C. Ensure floor substrate is clean and dry by using test methods recommended by flooring manufacturer.
- D. Ensure building area for flooring application is maintained at minimum 15°C (60° F), maximum 24°C (75°F) and at maximum 65% relative humidity for minimum 48 hours before installation, during installation and for minimum 72 hours after completion of work.
- E. Entire flooring shall be dry laid and inspected by installer under normal, occupied lighting conditions, to ensure proper color and fit prior to final adhesive installation.

3.2 CONCRETE FLOOR PREPARATION

- A. Prepare sub-floor in accordance with Manufacturer's instructions in the printed Installation Manual.
- B. Moisture tests must be taken on all concrete floors regardless of age and grade level.
- C. Test shall be in accordance with ASTM F-1869* Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- D. One test should be conducted for every 92.9030m² (1,000 sq.ft.) of flooring and the results not exceed 2.27 kg (5 lbs) per 92.9030m² (1,000 sq.ft.) in 24 hours.
 - 1. If test results exceed limitations or if hydrostatic pressure exists, the installation must not proceed until the problem has been corrected or an approved vapor barrier underlayment is installed.

3.3 APPLICATION: FLOORING

- A. See Manufacturer's printed Installation Procedures.

3.4 CLEANING AND MAINTENANCE

- A. Initial Cleaning: See Manufacturer's printed Installation Procedures for instructions.
- B. Do not proceed with cleaning until 72 hours minimum after installation if flooring has been glued down.
- C. Floor Finishing: Complete if required in project. A finish may alter the surface characteristic of the tile. Apply floor finish for rubber flooring according to instructions and application rate recommended by manufacturer.
- D. Regular Cleaning: See Manufacturer's printed Installation Procedures for regular cleaning instructions.

3.5 PROTECTION

- A. Protect and cover new floors from damage until final inspection.
- B. Prohibit traffic on floor for 24 hours after installation.
- C. Provide ventilation to installation area during installation and for minimum 72 hours after completion of work.

END OF SECTION 09 65 00

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SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.
 - 2. Rubber stair accessories.
 - 3. Rubber molding accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Laboratory Test Reports: For resilient base and stair products and accessories, indicating compliance with requirements for low-emitting materials.
 - 4. Environmental Product Declaration: For each product.
- C. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE (RB)

- 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. Johnsonite; a Tarkett company.
 - 2. Roppe Corporation, USA.
- B. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient floor coverings.
- C. Thickness: 0.125 inch (3.2 mm).
- D. Height: As indicated on Drawings.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Preformed.
- H. Colors: As selected by Architect from manufacturer's full product line.

2.2 RUBBER STAIR ACCESSORIES

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. **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. Johnsonite; a Tarkett company.
 - 2. Roppe Corporation, USA.

3. Style: Toeless, by length matching treads.
 4. Thickness: Manufacturer's standard.
- C. Stringers: Height and length after cutting to fit risers and treads and to cover stair stringers, produced by same manufacturer as treads, and recommended by manufacturer for installation with treads.
1. Thickness: Manufacturer's standard.
- D. Locations: Provide rubber stair accessories in areas indicated.
- E. Colors and Patterns: As selected by Architect from manufacturer's full product line.
- 2.3 RUBBER MOLDING ACCESSORY
- 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. Johnsonite; a Tarkett company.
 2. Roppe Corporation, USA.
- B. Description: Rubber transition strips.
- C. Profile and Dimensions: As selected from selected manufacturer's standard catalog .
- D. Locations: Provide rubber molding accessories in areas indicated.
- E. Colors and Patterns: As selected by Architect from manufacturer's full product line.
- 2.4 INSTALLATION MATERIALS
- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
1. Verify adhesives have a VOC content of 50 g/L or less.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Fill gap at bottom of gypsum board wall finish greater than 3/8 inch (9.525 mm) prior to installation.
- C. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

- D. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- E. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- F. Do not stretch resilient base during installation.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

3.3 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Stair Accessories:
 - 1. Tightly adhere to substrates throughout length of each piece.
 - 2. For treads installed as separate, equal-length units, install to produce a flush joint between units.
- C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.
 - 1. Apply two coat(s).
- C. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

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SECTION 09 65 19 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Product Data: For chemical-bonding compounds, indicating VOC content.
 - 4. Laboratory Test Reports: For chemical-bonding compounds, indicating compliance with requirements for low-emitting materials.
 - 5. Product Data: For sealants, indicating VOC content.
 - 6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
 - 7. Environmental Product Declaration: For each product.
- C. Samples: For each exposed product and for each color and pattern specified.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 SOLID VINYL FLOOR TILE (LVT)

- A. See drawings for Basis-of-Design.
- B. Tile Standard: ASTM F1700.
 - 1. Class: As indicated by product designations.
 - 2. Type: B, Embossed Surface.
- C. Thickness: 0.177 inch (4.5 mm).
- D. Size: 9 by 39 inches (25 by 100 cm).
- E. Colors and Patterns: As indicated by manufacturer's designations.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles at a 45-degree angle with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern).
- D. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- F. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed

on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

- G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

END OF SECTION 09 65 19

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SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Modular carpet tile.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Type of subfloor.
 - 4. Type of installation.
 - 5. Pattern of installation.
 - 6. Pattern type, location, and direction.
 - 7. Pile direction.
 - 8. Type, color, and location of insets and borders.
 - 9. Type, color, and location of edge, transition, and other accessory strips.
 - 10. Transition details to other flooring materials.
- D. Samples: For each exposed product and for each color and texture required.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.7 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE (CPT)

- A. See Drawings for Basis-of-Design.
- B. Color: As selected by Architect from manufacturer's full range.
- C. Pattern: Match Architect's samples.
- D. Fiber Content: 100 percent nylon 6, 6.
- E. Fiber Type: Antron Lumena.
- F. Pile Characteristic: Patterned Loop, Tip Shear pile.
- G. Density: Insert 6,500 oz./cu. yd. (240.34 kg/cu. cm).
- H. Pile Thickness: 0.128 inches (3.25 mm) for finished carpet tile according to ASTM D6859.
- I. Stitches: 9.66 stitches per inch (38.03 per 10 cm).
- J. Gage: 5/64 ends per inch (50.39 per 10 cm).
- K. Total Weight: 22 oz./sq. yd. (780 g/sq. m) for finished carpet tile.
- L. Primary Backing/Backcoating: Manufacturer's standard composite materials.
- M. Backing System: Infinity 2 Modular .
- N. Size: 24 by 24 inches (610 by 610 mm).
- O. Applied Treatments:
 - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.
 - 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
- P. Sustainable Design Requirements:
 - 1. Sustainable Product Certification: Gold level certification according to ANSI/NSF 140.
- Q. Performance Characteristics:
 - 1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
 - 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
 - 3. Dry Breaking Strength: Not less than 100 lbf (445 N) according to ASTM D2646.
 - 4. Tuft Bind: Not less than 6.2 lbf (28 N) according to ASTM D1335.
 - 5. Delamination: Not less than 4 lbf/in. (0.7 N/mm) according to ASTM D3936.
 - 6. Dimensional Tolerance: Within 1/32 inch (0.8 mm) of specified size dimensions, as determined by physical measurement.
 - 7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
 - 8. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
 - 9. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) according to AATCC 16, Option E.
 - 10. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

1. Verify adhesives have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Concrete Slabs:
 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- B. Wood Subfloors: Verify that underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

- I. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

SECTION 09 68 16 - SHEET CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Tufted carpet.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For carpet installation, showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
 - 2. Carpet type, color, and dye lot.
 - 3. Locations where dye lot changes occur.
 - 4. Seam locations, types, and methods.
 - 5. Type of subfloor.
 - 6. Type of installation.
 - 7. Pattern type, repeat size, location, direction, and starting point.
 - 8. Pile direction.
 - 9. Types, colors, and locations of insets and borders.
 - 10. Types, colors, and locations of edge, transition, and other accessory strips.
 - 11. Transition details to other flooring materials.
 - 12. Type of carpet cushion.
- D. Samples: For each exposed product and for each color and texture required.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.7 WARRANTY

- A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET

- A. Basis-of-Design: Align, Quadrant by Mannington Commercial.
- B. Color: As selected by Architect from manufacturer's full range.
- C. Pattern: Match Architect's samples.
- D. Fiber Content: 100 percent nylon 6, 6.
- E. Fiber Type: Antron Legacy .
- F. Pile Characteristic: Level-loop pile.
- G. Density: 7,269 oz./cu. yd. (270.10 kg/cu. cm).
- H. Pile Thickness: 0.104 inches (2.64 mm) for finished carpet according to ASTM D6859.
- I. Stitches: 9.67 stitches per inch (38.07 per 10 cm).
- J. Gage: 5/64 gage in ends per inch (50.39 per 10 cm).
- K. Total Weight: 21 oz./sq. yd. (712 g/sq. m) for finished carpet.
- L. Primary Backing: Manufacturer's standard material.
- M. Secondary Backing: Manufacturer's standard material.
- N. Backcoating: Manufacturer's standard material.
- O. Backing System: UltraBac RE, Integra HP .
- P. Roll Width: 12.5 feet (3.8 m).
- Q. Applied Treatments:
 - 1. Applied Soil-Resistance Treatment: Manufacturer's standard material.
 - 2. Antimicrobial Treatment: Manufacturer's standard material.
 - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
- R. Sustainable Design Requirements:
 - 1. Sustainable Product Certification: Gold level certification according to ANSI/NSF 140.
- S. Performance Characteristics:
 - 1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
 - 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
 - 3. Dry Breaking Strength: Not less than 100 lbf (445 N) according to ASTM D2646.
 - 4. Tuft Bind: Not less than 6.2 lbf (28 N) according to ASTM D1335.
 - 5. Delamination: Not less than 3.5 lbf/in. (0.6 N/mm) according to ASTM D3936.
 - 6. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
 - 7. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) according to AATCC 16, Option E.
 - 8. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.

- B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.
- C. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with the Carpet and Rug Institute's CRI 104.
- D. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Wood Subfloors: Verify that underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

- A. Comply with the Carpet and Rug Institute's CRI 104 and carpet manufacturer's written installation instructions for the following:
 - 1. Stair installation.
- B. Comply with carpet manufacturer's written instructions and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
- C. Install pattern parallel to walls and borders.
- D. Install borders with mitered corner seams.
- E. Do not bridge building expansion joints with carpet.
- F. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- G. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.

- I. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods recommended in writing by carpet manufacturer and carpet adhesive manufacturer.

END OF SECTION 09 68 16

SECTION 09 91 14 - EXTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Surface preparation and application of paint systems on the following exterior substrates:
 - a. Steel and iron.
 - b. Galvanized metal.
 - c. Wood.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For paints and coatings, indicating VOC content.
 - 2. Environmental Product Declaration (EPD): For each product.
 - 3. Health Product Declaration (HPD): For each product.
 - 4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - 5. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.
- C. Samples: For each type of topcoat product.
- D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.3 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. Dulux (formerly ICI Paints); a brand of AkzoNobel.
 - 3. Dunn-Edwards Corporation.
 - 4. Kwal Paint; Comex Group.
 - 5. PPG Architectural Coatings.
 - 6. Sherwin-Williams Company (The).

Retain "Products" Paragraph below and insert lists of manufacturers and products in the Exterior Painting Schedule to require specific products or a comparable product from other manufacturers.

2.2 PAINT PRODUCTS

- A. MPI Standards: Provide products complying with MPI standards indicated and listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. VOC Content: For field applications, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 50 g/L.
 - 3. Dry-Fog Coatings: 150 g/L.
 - 4. Primers, Sealers, and Undercoaters: 100 g/L.
 - 5. Rust-Preventive Coatings: 100 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Shellacs, Clear: 730 g/L.
 - 9. Shellacs, Pigmented: 550 g/L.
- D. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

3.3 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- B. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

- C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

A. Steel and Iron Substrates:

- 1. Water-Based Light Industrial Coating over Epoxy System MPI EXT 5.1R:
 - a. Prime Coat: Primer, epoxy, anti-corrosive MPI #101.
 - b. Intermediate Coat: Epoxy, high build, low gloss MPI #108.
 - c. Semigloss Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.

B. Galvanized-Metal Substrates:

- 1. Latex System MPI EXT 5.3H:
 - a. Water-Based Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.

END OF SECTION 09 91 14

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SECTION 09 91 24 - INTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete masonry units (CMUs).
 - 2. Steel and iron.
 - 3. Galvanized metal.
 - 4. Gypsum board.
 - 5. Spray-textured ceilings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Sustainable Design Submittals:
 - 1. Product Data: For paints and coatings, indicating VOC content.
 - 2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.
 - 3. Environmental Product Declaration: For each product.
- C. Samples: For each type of topcoat product.
- D. Product List: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.3 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

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. Behr Process Corporation.
 - 2. Benjamin Moore & Co.
 - 3. Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company).
 - 4. PPG Paints.
 - 5. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Emissions Requirements: Verify field-applied paints and coatings that are inside the weatherproofing system comply with one of the following:
1. Low-Emitting Materials: Verify VOC emissions comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:
 - a. Flat Coatings: 50 g/L.
 - b. Nonflat Coatings: 100 g/L.
 - c. Primers, Sealers, and Undercoats: 100 g/L.
 - d. Shellacs, Clear: 730 g/L.
 - e. Shellacs, Pigmented: 550 g/L.
- D. Colors: As selected by Architect from manufacturer's full range.
1. Twenty percent of surface area will be painted with deep tones.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
- C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Metal conduit.
 - d. Tanks that do not have factory-applied final finishes.
 - e. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

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

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. CMU Substrates:
 - 1. Latex System, MPI INT 4.2A:
 - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior (MPI Gloss Level 4), MPI #43.
- B. Steel Substrates:
 - 1. Latex System, Alkyd Primer, MPI INT 5.1QQ:
 - a. Prime Coat: Shop primer specified in Section where substrate is specified.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, semigloss (MPI Gloss Level 5), MPI #54.
- C. Galvanized-Metal Substrates:
 - 1. Latex System, MPI INT 5.3A:
 - a. Prime Coat: Primer, galvanized, cementitious, MPI #26.
 - b. Prime Coat: Primer, galvanized, water based, MPI #134.
 - c. Intermediate Coat: Latex, interior, matching topcoat.
 - d. Topcoat: Latex, interior, semigloss (MPI Gloss Level 5), MPI #54.
- D. Spray-Textured Ceiling Substrates:
 - 1. Latex, Flat System, MPI INT 9.1A: Spray applied.
 - a. Prime Coat: Latex, interior, flat, matching topcoat.
 - b. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.
- E. Gypsum Board and Plaster Substrates:
 - 1. Institutional Low-Odor/VOC Latex System, MPI INT 9.2M:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.

END OF SECTION 09 91 24

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SECTION 09 93 00 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wood stains.
 - 2. Transparent finishes.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of finish system and in each color and gloss of finish required.
- C. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.
- D. Sustainable Design Submittals:
 - 1. Product Data: For paints and coatings, indicating VOC content.
 - 2. Laboratory Test Reports: For paints and coatings, indicating compliance with requirements for low-emitting materials.
 - 3. Environmental Product Declaration: For each product.

1.3 MOCKUPS

- A. Apply mockups of each finish system indicated and each color selected to demonstrate aesthetic effects and to set quality standards for materials and execution.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
- B. Emissions Requirements: Verify field-applied paints and coatings that are inside the weatherproofing system comply with one of the following:
 - 1. Low-Emitting Materials: Verify VOC emissions comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:
 - a. Shellacs, Clear: 730 g/L.
 - b. Stains: 250 g/L.
 - c. Clear Wood Finishes (Varnishes, Sanding Sealers, and Lacquers): 275 g/L.
- C. Stain Colors: As selected by Architect from manufacturer's full range.

2.2 WOOD STAINS

- A. Stain, Interior, Semitransparent, for Interior Wood: Solvent-based, oil or oil/alkyd, semitransparent, pigmented stain for new interior wood surfaces that are to be finished with a clear varnish.

2.3 TRANSPARENT FINISHES

- A. Varnish, Interior Polyurethane, Moisture Cured, Gloss: Solvent-based, moisture-curing polyurethane clear-coating with a gloss finish for interior wood surfaces.
 - 1. Gloss Level: Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523.
- B. Varnish, Interior, Polyurethane, Oil Modified, Gloss: Solvent-based, one-component, oil-modified polyurethane clear gloss varnish for new or previously varnished or stained interior wood surfaces.
 - 1. Gloss Level: Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523.
- C. Varnish, Interior, Gloss: Solvent-based, alkyd-type, clear gloss varnish for new or properly prepared, previously varnished interior wood surfaces.
 - 1. Gloss Level: Gloss of 70 to 85 units at 60 degrees when tested in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- B. Maximum Moisture Content of Interior Wood Substrates: 9 percent, when measured with an electronic moisture meter.

3.2 PREPARATION

- A. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 - 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.
 - 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 - 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions.
- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

- A. Wood Substrates, Wood Trim, Architectural Woodwork and Doors:
 - 1. Water-Based Varnish over Stain System:
 - a. Stain Coat: Stain, semitransparent, for interior wood.
 - b. First Intermediate Coat: Water-based varnish matching topcoat.
 - c. Second Intermediate Coat: Water-based varnish matching topcoat.
 - d. Topcoat: Varnish, water based, clear, gloss.
 - 2. Polyurethane Varnish over Stain System:

- a. Stain Coat: Stain, semitransparent, for interior wood.
 - b. First Intermediate Coat: Polyurethane varnish matching topcoat.
 - c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
 - d. Topcoat: Varnish, interior, polyurethane, oil modified, gloss.
3. Moisture-Cured Clear Polyurethane over Stain System:
- a. Stain Coat: Stain, semitransparent, for interior wood.
 - b. First Intermediate Coat: Moisture-cured polyurethane matching topcoat.
 - c. Second Intermediate Coat: Moisture-cured polyurethane matching topcoat.
 - d. Topcoat: Varnish, polyurethane, moisture cured, gloss.

END OF SECTION 09 93 00

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SECTION 10 14 23.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes room-identification signs that are directly attached to the building.
- B. Related Requirements:
 - 1. Section 10 14 16 "Plaques" for one-piece, solid metal signs, with or without frames, that are used for high-end room-identification.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. **Product Data:** For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- D. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design," the ABA standards of the Federal agency having jurisdiction and ICC A117.1 Insert requirement.

2.2 ROOM-IDENTIFICATION SIGNS

- A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 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. Advance Corporation.
 - b. ASI Sign Systems, Inc.
 - c. Best Sign Systems, Inc.
 - d. Clarke Systems.

- e. Inpro Corporation.
- 2. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated to acrylic or phenolic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign.
 - b. Surface-Applied Graphics: Applied vinyl film.
 - c. Subsurface Graphics: Reverse etch image.
 - d. Color(s): As selected by Architect from manufacturer's full range.
- 3. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Square cut.
 - b. Corner Condition in Elevation: Square.
- 4. Mounting: Manufacturer's standard method for substrates indicated with.

2.3 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Vinyl Film: UV-resistant vinyl film with pressure-sensitive, permanent adhesive; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. For exterior exposure, furnish nonferrous-metal or hot-dip galvanized unless otherwise indicated.
 - 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened sign unless otherwise indicated.
 - 4. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
 - b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
 - 1. Verify adhesives have a VOC content of 70 g/L or less.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 2. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 3. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- C. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Mounting Methods:
1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
 2. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
 3. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 4. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

END OF SECTION 10 14 23.16

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SECTION 10 1426 - POST AND PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nonilluminated post-and-panel signs.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signage.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least quarter size.
- C. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
- B. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design."

2.2 POST-AND-PANEL SIGNS

- A. Accessible Parking Post-and-Panel Sign: Single-panel configuration; with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Solid-Sheet Sign Panels: Aluminum sheet with finish specified in "Sign-Panel-Face Finish and Applied Graphics" Subparagraph and as follows:

- a. Surface-Applied Graphics: Applied baked enamel or powder coat paint.
- 2. Posts: Steel.
 - a. Shape: Round and square.
 - b. Sizes: 8-inch diameter and 2 by 2 inches.
 - c. Installation Method: Direct burial.
 - d. Finish and Color: Galvanized and painted per Drawings.
- 3. Sign-Panel-Face Finish and Applied Graphics:
 - a. Painted Finish and Graphics: Manufacturer's standard, factory-applied exterior-grade sign paint, in colors as indicated.
 - b. Overcoat: Manufacturer's standard baked-on clear coating.

2.3 MATERIALS

- A. Aluminum Sheet: ASTM A 209, stretcher-leveled standard of flatness.
- B. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
 - 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Mill joints to tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
 - 3. Conceal fasteners and anchors unless indicated to be exposed; locate exposed fasteners where they will be inconspicuous.
 - 4. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
- B. Post Fabrication: Fabricate posts designed for structural performance indicated and of lengths required for installation method indicated for each sign.

1. Steel Posts: Fabricate from minimum thickness indicated on Drawings, steel tubing unless otherwise indicated.
 - a. Hot-dip galvanize post assemblies after fabrication according to ASTM A 123/A 123M.
2. Direct Burial: Fabricate posts 42 inches longer than height of sign to permit direct burial or embedment in concrete foundations or concrete-filled postholes.
3. Sleeves: Fabricate posts longer than height of sign to permit embedment in sleeves cast in concrete foundations or concrete-filled postholes. Size sleeves for direct embedment in concrete foundations or concrete-filled postholes and to prevent sign movement, but not less than 24 inches for embedment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using installation methods indicated and according to manufacturer's written instructions.
 1. Install signs level, plumb, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 3. Before installation, verify that sign components are clean and free of materials or debris that would impair installation.
 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING POSTS

- A. Direct-Burial Method:
 1. Excavation: Excavate posthole to dimensions indicated. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by freezing temperatures, frost, rain, accumulated water, or construction activities by excavating an additional 12 inches, backfilling with satisfactory soil or well-graded aggregate, and compacting to original subgrade elevation.
 2. Setting in Cast-in-Place Concrete: Set post in position, support to prevent movement, and place concrete for concrete foundation as indicated on Drawings.

END OF SECTION 10 1426

SECTION 10 21 13.17 - PHENOLIC-CORE TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Phenolic-core toilet compartments configured as toilet enclosures and urinal screens.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachment details.
- D. Samples for each type of toilet compartment material indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent.
- C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 PHENOLIC-CORE TOILET COMPARTMENTS

- 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. ASI Accurate Partitions
 - 2. ASI Global Partitions
 - 3. Bobrick Washroom Equipment
 - 4. Bradley Corporation
 - 5. Marlite
 - 6. PSISC
- B. Toilet-Enclosure Style: Floor and ceiling anchored.
- C. Urinal-Screen Style: Post to ceiling.

- D. Pilaster Shoes and Sleeves (Caps): Formed from stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
- E. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters; with shoe and sleeve (cap) matching that on the pilaster.
- F. Brackets (Fittings):
 - 1. Full-Height (Continuous) Type: Manufacturer's standard design; aluminum.
- G. Phenolic-Panel Finish:
 - 1. Facing Sheet Finish: One color and pattern in each room.
 - 2. Color and Pattern: As selected by Architect from manufacturer's full range, with manufacturer's standard dark color core.
 - 3. Edge Color: Manufacturer's standard.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
 - 1. Material: Chrome-plated zamac.
 - 2. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
- B. Hardware and Accessories: Manufacturer's heavy-duty stainless steel operating hardware and accessories.
 - 1. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
- C. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- D. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Floor-and-Ceiling-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
- C. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at tops and bottoms of posts. Provide shoes and sleeves (caps) at posts to conceal anchorage.
- D. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide out-swinging doors with a minimum 32-inch- (813-mm-) wide clear opening for compartments designated as accessible.

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 (13 mm).
 - b. Panels and Walls: 1 inch (25 mm).
 - 2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware 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 13.17

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SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Hand dryers.
 - 3. Childcare accessories.
 - 4. Underlavatory guards.
 - 5. Custodial accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each finish specified, full size.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Delegated Design Submittal: For grab bars.
 - 1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- 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. Structural Performance: Design accessories and fasteners to comply with the following requirements:
 - 1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Toilet Tissue (Roll) Dispenser: (TP)
 - 1. Basis-of-Design: B-2888 Surface-Mounted Multi-Roll Toilet Tissue Dispenser by Bobrick
 - 2. Description: Double-roll dispenser.
 - 3. Mounting: Surface mounted.
 - 4. Operation: Noncontrol delivery with theft-resistant spindle.
 - 5. Capacity: Designed for 5-inch- (127-mm-) diameter tissue rolls.
 - 6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

- B. Automatic Soap Dispenser: (SD)
 - 1. Basis-of-Design: B-2013 Automatic Wall-Mounted Foam Soap Dispenser by Bobrick
 - 2. Description: Automatic dispenser with infrared sensor to detect presence of hands; battery powered; designed for dispensing soap in lather form.
 - 3. Mounting: Surface mounted.
 - 4. Capacity: 800 ml (27-fl.oz.).
 - 5. Materials: Type 304 Stainless Steel with Satin finish.
 - 6. Refill Indicator: LED indicator.
 - 7. Low-Battery Indicator: LED indicator.
- C. Grab Bar: (GB)
 - 1. Mounting: Flanges with concealed fasteners.
 - 2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
 - 3. Outside Diameter: 1-1/2 inches (38 mm).
 - 4. Configuration and Length: As indicated on Drawings.
- D. Sanitary-Napkin Disposal Unit: (ND)
 - 1. Mounting: Surface mounted.
 - 2. Door or Cover: Self-closing, disposal-opening cover.
 - 3. Receptacle: Removable.
 - 4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
- E. Mirror Unit: (MIRR)
 - 1. Frame: Stainless steel angle, 0.05 inch (1.3 mm) thick.
 - a. Corners: Manufacturer's standard.
 - 2. Size: 24 by 36 inches high.
 - 3. Hangers: Manufacturer's standard rigid, tamper and theft resistant.
- F. Hook:
 - 1. Provide 3 hooks in each restroom. Coordinate location with Owner.
 - 2. Description: Double-prong unit.
 - 3. Mounting: Concealed.
 - 4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.3 HAND DRYERS

- A. High-Speed Air Dryer: (HD)
 - 1. Description: High-speed, warm-air hand dryer for rapid hand drying.
 - 2. Mounting: Surface mounted.
 - a. Protrusion Limit: Installed unit protrudes maximum 4 inches (102 mm) from wall surface.
 - 3. Operation: Infrared-sensor activated with timed power cut-off switch.
 - a. Average Dry Time: 12 seconds.
 - b. Automatic Shut Off: At 60 seconds.
 - 4. Maximum Sound Level: 75 dB.
 - 5. Cover Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - 6. Electrical Requirements: 115 V, 20 A, 2300 W.

2.4 CHILDCARE ACCESSORIES

- A. Diaper-Changing Station: (DCS)
 - 1. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support minimum of 250-lb (113-kg) static load when opened.
 - 2. Mounting: Surface mounted, with unit projecting not more than 4 inches (102 mm) from wall when closed.
 - 3. Operation: By pneumatic shock-absorbing mechanism.
 - 4. Material and Finish: HDPE in manufacturer's standard color.
 - 5. Liner Dispenser: Provide built-in dispenser for disposable sanitary liners.

2.5 UNDERLAVATORY GUARDS

- A. Underlavatory Guard:
 - 1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.

2. Material and Finish: Antimicrobial, molded plastic, white.

2.6 CUSTODIAL ACCESSORIES

- A. Custodial Mop and Broom Holder:
 1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
 2. Length: 36 inches (914 mm).
 3. Hooks: Four.
 4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
 5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
 - b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

2.7 FABRICATION

- A. 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.
 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.

END OF SECTION 10 28 00

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SECTION 10 44 13 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets for portable fire extinguishers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fire-protection cabinets.
- C. Samples: For each type of exposed finish required.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.4 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Cabinet Construction: Nonrated or One-hour fire rated. See plan for location in rated walls.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- (1.09-mm-) thick cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Cold-rolled steel sheet.
- D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
 - 1. Rolled-Edge Trim: 2-1/2-inch (64-mm) backbend depth.
- E. Cabinet Trim Material: Same material and finish as door.
- F. Door Material: Steel sheet.
- G. Door Style: Fully glazed panel with frame.
- H. Door Glazing: Tempered float glass (clear).
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
- J. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
3. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
4. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
5. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet glazing.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.

K. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
 - b. Color: As selected by Architect from manufacturer's full range.
2. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.3 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.
- B. Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- C. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
- D. Identification: Apply vinyl lettering at locations indicated.
- E. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

END OF SECTION 10 44 13

SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- 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. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - 2. Kidde Residential and Commercial Division.
 - 3. Larsens Manufacturing Company.
 - 4. Potter Roemer LLC.
- B. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.
 - 1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- C. Regular Dry-Chemical Type: UL-rated 2-A, 10-B-C, 7.5 lb. nominal capacity, with sodium bicarbonate-based dry chemical in manufacturer's standard enameled container.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.

- B. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 10 44 16

SECTION 12 36 23.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-clad countertops.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
 - 3. Product Data: For installation adhesives, indicating VOC content.
 - 4. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
 - 5. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
- C. Shop Drawings: For plastic-laminate-clad countertops.
- D. Samples: Plastic laminates in each type, color, pattern, and surface finish required.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For the following:
 - 1. Composite wood products.
 - 2. High-pressure decorative laminate.
 - 3. Adhesives.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.5 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install wood countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations with Humidity Control: Do not deliver or install wood countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 20 and 50 percent during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.
- B. Grade: Custom.
- C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGL.

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. Formica Corporation.
 - b. Lamin-Art, Inc.
 - a. Nevamar; a Panolam Industries International, Inc. brand.
 - b. Wilsonart LLC.
 - D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 1. As indicated by manufacturer's designations.
 2. Match Architect's sample.
 3. As selected by Architect from manufacturer's full range in the following categories:
 - a. Wood grains, matte finish with grain running parallel to length of countertop.
 - b. Patterns, matte finish.
 - E. Edge Treatment: 3.0-mm PVC edging.
 - F. Core Material: MDF, MDF made with exterior glue or Exterior-grade plywood.
 - G. Core Thickness: 3/4 inch (19 mm).
 1. Build up countertop thickness to 1-1/2 inches (38 mm) at front, back, and ends with additional layers of core material laminated to top.
 - H. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.
 - I. Paper Backing: Provide paper backing on underside of countertop substrate.
- 2.2 WOOD MATERIALS
- A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.
 1. Wood Moisture Content: 5 to 10 percent.
 - B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of countertop and quality grade specified unless otherwise indicated.
 1. Composite Wood Products: Verify products are made without added urea formaldehyde.
 2. Recycled Content of MDF and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 75 percent.
 3. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.
 4. Softwood Plywood: DOC PS 1.
- 2.3 ACCESSORIES
- A. Wire-Management Grommets: Circular, molded-plastic grommets and matching plastic caps with slot for wire passage.
 1. Outside Diameter: 2 inches (51 mm).
 2. Color: Black,
- 2.4 MISCELLANEOUS MATERIALS
- A. Adhesives: Do not use adhesives that contain urea formaldehyde.
 - B. Adhesive for Bonding Plastic Laminate: As selected by fabricator to comply with requirements.
 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.
 - C. Installation Adhesive:
 1. Verify adhesives have a VOC content of 70 g/L or less.

2.5 FABRICATION

- A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch (25 mm) over base cabinets. Ease edges to radius indicated for the following:
 - 1. Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.
- B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Grade: Install countertops to comply with same grade as item to be installed.
- B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
 - 1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 2. Seal edges of cutouts by saturating with varnish.
- C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
 - 1. Secure field joints in countertops with concealed clamping devices located within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches (3-mm-in-2400-mm) variation from a straight, level plane.
 - 2. Secure backsplashes to walls with adhesive.
 - 3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.
- F. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches (1220 mm) o.c. Remove protection at Substantial Completion.

END OF SECTION 12 36 23.13

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SECTION 12 36 61.19 - QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Quartz agglomerate countertops.
 - 2. Quartz agglomerate apron fronts.

1.2 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
- D. Samples: For each type of material exposed to view.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

- A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
 - 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. Caesarstone.
 - b. Cambria.
 - c. LG Chemical, Ltd.
 - d. Samsung Chemical USA, Inc.
 - e. Wilsonart LLC.
 - 2. Colors and Patterns: As selected by Architect from manufacturer's full range.
- B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Configuration:
 - 1. Front: Straight, slightly eased at top with separate apron, 6 inches (150 mm) high, continuous with front edge.
- C. Countertops: 3/4-inch- (19-mm-) thick, quartz agglomerate with front edge built up with same material.
- D. Joints: Fabricate countertops without joints.
- E. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate manufacturer.

1. Verify adhesives have a VOC content of 70 g/L or less.

B. Sealant for Countertops: Comply with applicable requirements in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer.
- B. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions.
- C. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
- D. Install aprons to backing and countertops with adhesive.
- E. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- F. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

END OF SECTION 12 36 61.19

SECTION 13 1000 – WATER FEATURE PERFORMANCE STANDARD

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the minimum Performance and Design Requirements for Swimming Pools, Spa Pools, Hot Tubs, Decorative Waterfalls, and Fountains. These requirements include the following:
 - 1. Acceptable Bather Load Limits
 - 2. Acceptable Flow Rates and Pipe Velocities
 - 3. Required Turnover Rates
 - 4. Acceptable Filter Flow Rates
 - 5. Design Requirements for Bottom Drains
 - 6. Design Requirements for Skimmers & Gutters
 - 7. Design Requirements for Floor and Wall Inlet Jets
 - 8. Design Requirements for Hydrotherapy Jets
 - 9. Lighting and Grounding Requirements
 - 10. Minimum Reinforcing Requirements and Water/Cement Ratios
 - 11. Pool Finish Requirements
 - 12. Design Requirements for Sloping the Pool Floor & Walls
 - 13. Minimum Requirements for Balance Tanks and Backwash Tanks
 - 14. Minimum Chemical Dosing Requirements
 - 15. Minimum Shop Drawing Submittal Requirements
- B. This document does not include specifications for equipment and materials. Refer to “Related Sections” for specific equipment and material requirements.
- C. Related Sections:
 - 1. SECTION 13 1305 – WATER FEATURE ACCESSORIES
 - 2. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
 - 3. SECTION 13 1404 – WATER FEATURE WHITE GOODS
 - 4. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 5. SECTION 13 1503 – WATER FEATURE FILTERS
 - 6. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 7. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
 - 8. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
 - 9. SECTION 13 1507 – WATER FEATURE HEATERS
 - 10. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
 - 11. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
 - 12. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
 - 13. SECTION 13 1512 – WATER FEATURE COMPRESSED AIR SYSTEMS
 - 14. SECTION 13 1513 – WATER FEATURE LOW PRESSURE AIR SYSTEMS
 - 15. SECTION 13 1601 – WATER FEATURE GENERAL ELECTRICAL REQUIREMENTS
 - 16. SECTION 13 1602 – WATER FEATURE CONTROLS
 - 17. SECTION 13 1604 – WATER FEATURE FIELD INSTRUMENTS, SWITCHES, AND ALARMS
 - 18. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
 - 19. SECTION 13 1606 – WATER FEATURE INSTRUMENT POWER SYSTEMS
 - 20. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS
 - 21. SECTION 13 1608 – WATER FEATURE LIGHTING AND CONTROL
 - 22. SECTION 13 1609 – WATER FEATURE DISCONNECTS, MCC, AND STARTERS
 - 23. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
 - 24. SECTION 13 1611 – WATER FEATURE GROUNDING

1.2 REFERENCES

- A. Applicable Standards: The following standards are referenced herein.
 - 1. PVC Pipe Institute
 - 2. Uniform Swimming Pool, Spa, & Hot Tub Code
 - 3. ANSI/NSF International Standard 50 – Circulation System Components and Related Materials for Swimming Pool, Spas/Hot Tubs
 - 4. NFPA 70 – National Electrical Code (NEC)
 - 5. ASME/APSP-16 – a.k.a. the Virginia Graeme Baker Pool and Spa Safety Act
 - 6. 2010 ADA Standards for Accessible Design

1.3 DEFINITIONS

- A. Bathing Load: The maximum number of persons allowed in the pool, spa or hot tub at one time
- B. Balance Tank: A reservoir, open to the atmosphere, from which the recirculation pump takes suction, which receives the gravity flow from the main drain and surface overflow system
- C. Makeup Water: Replacement water removed from the pool by bather drag out, splashing, evaporation, and filter backwash
- D. NTU: Nephelometric Turbidity Unit which is a means of measuring water clarity
- E. Perimeter Overflow Gutter: A level trough or ledge around the inside perimeter of the pool containing drains to clean the pool water surface
- F. Pool Floor: The interior pool bottom surface, which consists of that area from a horizontal plan up to a maximum of a 45-degree slope
- G. Pool Wall: The interior poolside surface, which consists of that area from a vertical plane to a 45-degree slope
- H. Pool Turnover: The circulation of the entire pool volume through the filter system
- I. Recirculation System: The system of piping and mechanical equipment designed to remove the water from the pool filter, disinfect, and return it to the pool
- J. Water Quality: The bacteriological and chemical analysis of the pool water that meets the minimum potable water standards as established by the United States Environmental Protection Agency
- K. Wet Deck Area: A four foot (1.2m) wide unobstructed pool deck area around the outside of the pool water perimeter, curb, ladders, handrails, waterfalls, water features, planters, starting blocks, or lifeguard chairs

1.4 SUBMITTALS

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Submit Shop Drawings indicating layout and piping plans for swimming pools, spa pools, kiddy pools, and fountains. Drawings to be accurate and precise showing all pertinent information as indicated in this specification. Drawings to be signed and sealed by a professional engineer having an active license within the jurisdiction of the project.
- C. Submit Mechanical Shop Drawings indicating mechanical equipment layout and equipment room piping. A process diagram indicating the treatment and circulation of all water features shall also be submitted as a shop drawing. All drawings to be accurately drawn including all mechanical equipment show at actual size and dimensions
- D. Submit Electrical Shop Drawings indicating power loads, one-line diagrams, and controls for all mechanical equipment
- E. Submit Shop Drawing details showing the construction of all edges, inlets drains, skimmers, handrails, grounding, lights, methods of waterproofing, finishes, etc.

- F. Submit Shop Drawings indicating layout and piping plans for swimming pools, spa pools, kiddie pools and fountains. Drawings to be accurate and precise showing all pertinent information as indicated in this specification

1.5 WARRANTY

- A. Contractors Warranty: Contractor shall warrant the feature against defects caused by faulty workmanship or materials for a minimum period of one (1) year from Date of Substantial Completion. The warranty will cover all surfaces, sub-surfaces, equipment, piping, valves, etc. and will bind the contractor to repair, at his expense, all defects.

1.6 SYSTEM DESCRIPTION

- A. Swimming Pool, Spa, & Hot Tub systems include the pool shell, piping, mechanical and electrical equipment necessary to hold, circulate, filter, and treat the water to provide a safe aesthetic environment for bathers and guest to interact with the water element. This includes any waterfalls or fountains that are directly related to the pool.

1.7 DESIGN REQUIREMENTS

- A. Pool bather load shall be determined as follows:
 - 1. Pool depth greater than three (3) feet (1.0m): 1 person per every 25 sq. ft (2.5 sq. m)
 - 2. Pool depth less than three (3) feet (1.0m): 1 person per every 15 sq. ft (1.5 sq. m)
- B. Pool Recirculation Systems:
 - 1. Pool recirculation systems shall be designed to continuously operate 24 hours a day 7 days per week
 - 2. All pipes associated with the swimming pool, spa, or water feature shall be sized appropriately to maintain the following pipe velocities
 - a. Gravity Line: 2.0 to 2.5 ft/s (0.6 to 0.8 m/s)
 - b. Direct Suction Line: 2.5 to 3.0 ft/s (0.8 to 1.0 m/s)
 - c. Pressurized Discharge Pipe: maximum 5.0 ft/s (1.5 m/s)
- C. Water Level Control:
 - 1. Automatic Water Makeup System shall be incorporated with each pool such that water level is constantly maintained at an elevation suitable for continuous skimming without flooding skimmers or gutters during periods of non-use
 - 2. Pool water level shall be controlled by using either skimmers or a continuous perimeter gutter. Skimmers and Gutters shall be constructed so the lip is level within 1/4 inch (6mm) between the highest and lowest point along the entire perimeter of the gutter.
- D. Water Treatment System:
 - 1. Turnover rate of two (2) to three (3) hours is appropriate in most pools. Pools with consistently high bather loads such as slide pools and rivers shall be designed with a one (1) to two (2) hour turnover rate. Children's pools and spa pools shall be designed with a 30 minute turnover rate. See drawings for specific design for each pool
 - 2. The circulation system shall be designed so 100% of the filtered flow rate can be circulated through the skimmer/gutter. Recessed Automatic Skimmers can be utilized on pools under 1,000 sq. ft (100 sq. m) of surface area. Minimum flow rate through a Recessed Automatic Skimmer is 30 gpm (110 lpm). One skimmer shall be provided for every 400 sq. ft (40 sq. m) of surface area. Perimeter gutter shall be installed on all pools over 1,000 sq. ft (100 sq. m)
 - 3. All skimmers and gutters shall discharge by gravity into a balance tank
 - 4. Water Treatment Pumps shall be installed so the inlet is a minimum 24 inches (0.6m) below the surface of the pool water. Basket strainers shall be installed on the suction side of each treatment pump

5. Treatment Pumps shall be designed to circulate the design volume of filtered water when the filter is in a dirty condition. The engineer shall calculate the hydraulic losses of the system and size the pump for the appropriate total head
 6. Filters shall be sized to handle the required circulation flow rate at the following allowable filtration rates:
 - a. Regenerative Media Filters: 0.5-1.4 gpm/sq. ft (1.22-3.42 cu. m/hr per sq. m) of filter area maximum
 - b. High Rate Sand Filters: 15 gpm/sq. ft (36 cu. m/hr per sq. m) of filter surface area maximum
 - c. Cartridge Filters: 0.33 gpm/sq. ft (0.8 cu. m/hr per sq. m) of filter surface area maximum.
- E. Inlets and Drains
1. All pool inlets shall be adjustable. Wall inlets being directionally adjustable and floor inlets have flow adjustment. Maximum design flow through wall or floor inlets is 20 gpm (75 lpm)
 2. Wall inlets shall be installed a minimum of 12 inches (0.3m) below normal operating water level
 3. Floor inlets shall be spaced maximum of 15 feet (5m) and within 10 feet (3m) of the pool wall
 4. All pools shall be provided with at least two main drains in the deepest part of the pool. Drains must be covered by a secured grating, which requires the use of a tool to remove. The open area in the grate shall be such that the maximum velocity through the grate does not exceed 0.5 ft/s (0.15 m/s) at 100% of the designed flow rate of the drain
- F. Meters and Instrumentation
1. A flow meter or flow indicator shall be installed on the return line for each pool
 2. Pressure gauges shall be installed such that discharge pressure from each pump and filter pressures may be easily read
 3. Temperature indicators shall be installed to read pool water temperature (upstream of any heating equipment) and the water temperature returning to the pool
- G. Water Quality Control, Sanitation, Oxidation, and pH
1. Ozone generation and injection shall be utilized for its superior sanitation and oxidation performance. Ozone is sized based on the anticipated bather load and total water volume to be treated. Ozone shall be controlled by ORP, separately from the chemical residual ORP
 2. Residual Sanitizer (Chlorine) and pH (Acid) adjustment shall be accomplished by the use of a Chemical Controller and Automatic Feeder System for each pool. Chemical containment tanks should be combined into common storage for all pool systems within each given mechanical space
- H. Pool System Automation
1. An automation system shall be incorporated into each mechanical room to monitor system performance and allow operations to control functions, such as filter backwash, chemical dosing, water level, safety interlocks, and pool temperature
 2. The automation system shall monitor water chemistry parameters and temperature history for each pool and log these for facility records and reporting to the local health department or ministry as required
 3. Pool automation system shall interface with ride control systems providing mutual interlocks for guest safety.
- I. Access:
1. Each pool shall have means of accessible entry/exit (stair, ladder, or recessed treads) within every 75 feet (25m) of the pool perimeter. A minimum of two accessible entries shall be installed in each pool and located to serve both ends of the pool

2. Stair access into the pool shall have a tread length of 4 feet (1.2m) and tread width of 12 inches (0.3m) minimum and a maximum tread riser height of 10 inches (0.25m)
 3. Swim outs shall extend 18 to 24 inches (0.5 – 0.6m) from the pool wall and a maximum of 12 inches (0.3m) below the pool deck. Swim outs shall be provided only in areas where water depth is 5 feet (1.5m) or greater
 4. Benches shall extend 14 – 18 inches (0.35 – 0.5m) from the pool wall and shall be located in areas where the water depth is 3 feet (1.0m) deep or less
 5. A permanent dark contrasting tile band shall be installed at the edge of each stair, swim out, or bench
 6. Handrails shall be provided for all stairs and shall be anchored in the bottom step and the deck. Grab rails must be mounted in the pool deck at each side of recessed steps and ladders. Handrails and Grab rails shall extend at least 28 inches (0.7m) above the step edge or pool deck.
 7. A pool lift shall be provided for each pool less than 300 feet (90m) of pool perimeter. Two compliant means of access shall be provided for pool with more than 300 feet (90m) of perimeter, one of which must be a pool lift or sloped entry.
 - a. Compliant means of entry include:
 - i. Pool Lift
 - ii. Slope Entry
 - iii. Transfer Wall
 - iv. Transfer System
 - v. Pool Stair with two handrails space 24 inches (0.6m) apart
- J. Pool Shell Construction:
1. Pool shells shall be constructed of concrete or shotcrete and shall be watertight, free from structural cracks, and shall have a nontoxic smooth and slip resistant finish
 2. All pool, spa, and hot tub shells shall be constructed of a concrete/shotcrete mixture having a water/cement ratio of 0.40 and 28-day compressive strength of 5,000 psi (34.5 MPa)
 3. Pool shells shall be steel reinforced according to the American Concrete Institute (ACI) guidelines for watertight concrete structures
 4. Pool walls shall be within 5-degrees of vertical for a minimum depth of 2.5 feet (0.8m) from which point the wall may join the floor with a maximum radius of 2.5 feet (0.8m)
 5. Corner intersections of walls that protrude or angle into the pool water area shall be rounded with a minimum radius of 2 inches (50mm)
 6. Floor slopes shall be uniform. The floor shall be a maximum 1:12 slope in areas 5 feet (1.5m) or less in depth. Floor slope shall be a maximum of 1:3 in areas more than 5 feet (1.5m) deep
 7. Transition in floor slope shall occur only when water is a minimum of 5 feet (1.5m) deep. A slope transition must have a 2 to 6 inch (50 – 150mm) wide dark contrasting tile marking across the bottom and must extend up both sides of the pool at the transition point
- K. Pool Finishes and Markings:
1. Finishes shall be white or light pastel in color and shall have characteristics of reflecting rather than absorbing light.
 2. Waterline Tile shall be a minimum 6 inches (150mm) tile band installed at the waterline
 3. A contrasting tile band shall be installed at all changes in the pool floor including slope changes, stairs, and benches.
 4. Any design or logo on the pool floor or wall shall be such that it will not hinder the detection of a human in distress, algae, sediment, or other objects in the pool
 5. Permanent depth markers shall be placed at every one (1) foot (0.3m) change in pool depth and spaced no more than 25 feet (8m) apart. Depth markers shall be accurate within 3 inches (75mm) of actual pool depth. Depth markers shall be located on the horizontal deck and on the vertical pool wall in the waterline tile. The text height of the marker shall be 4 inches (0.1m) in height

6. No diving markers are only placed on the horizontal deck and should accompany depth markers.
- L. Lighting and Grounding
 1. Underwater lighting shall provide a minimum 0.5 watt per sq. ft (6 W/sq. m) of pool surface area based upon incandescent light output per watt. The maximum lamp size for underwater fixtures shall be 300 Watts. Lights shall be located a minimum of 18 inches (0.5m) below water level and provide a protection from overheating when not submerged
 2. Reinforcement shall be grounded with all metal finishes, such as light housings, handrails, etc. per the National Electrical Code (NEC) requirements.
- M. Special Design Requirements for Spa Pools and Hot Tubs
 1. Spa pool bather load shall not exceed one (1) person per 10 sq. ft (1.0 sq. m) of spa surface area
 2. Spa pools shall have a maximum water depth of 3 ft and 3 inches (1.0m)
 3. The floor of the spa shall have a maximum slope of 1:48 to the bottom drains
 4. The spa pool shall have a means of accessible stair entry/exit. Minimum stair length is 4 feet (1.2m). Tread and risers shall meet the requirements above
 5. Benches shall be continuous around the perimeter of the spa with a maximum seating height of 20 inches (0.5m) and a minimum seating height of 14 inches (0.35m) measured from the bottom of the spa. Bench seat shall be 18 inches (0.5m) wide.
 6. A permanent dark contrasting tile band shall be installed at the front edge of the bench seat at all changes in seating height.

PART 2 - PRODUCTS – Not Used**2.1 SUBSTITUTIONS**

- A. Substitutions of equipment make and models are only allowed if the substituted equipment conforms to the specifications and is mentioned as an approved manufacturer therein. See "Related Sections" in the summary of this specification for reference to equipment specifications.

PART 3 - EXECUTION**3.1 OPERATION**

- A. Manual testing of the pool water shall be performed on a daily basis immediately after water is placed in the pool the first time. During this time, it is important to maintain a balanced water condition to prevent damage to the pool shell, finishes, and equipment
- B. Daily records shall be kept regarding pool operation, water quality, testing chemical injection, and balanced water chemistry
- C. The Contractor is responsible for maintaining balanced pool water and keeping daily records until the system is formally turned over to the owner. Once the system is formally turned over, the owner is responsible for maintaining balanced water and keeping daily records

3.2 DESIGNATION / LABELING

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer
- B. Install tags with corrosion resistant chain

3.3 CONTROLS PROGRAMMING

- A. Functional Requirements
 1. Controls provide all functions described herein for each individual pool/water feature. Water Feature Controller (WFC) includes controlling and monitoring of pumps, water filtration, chemical feed, and lighting

2. The Contractor shall refer to the Water Treatment Drawings to determine which pumps, filter controller, and chemical controller are associated with a given pool, spa, or feature. The system addressed in this specification include:
 - B. Pump Control
 1. All pump controls include HAND-OFF-AUTO (HOA) selector switch as shown on the drawings at the control center. HAND and OFF positions indicate manual control. AUTO control shall be determined by the PLC. In no case shall the pump operate in over-ride of safety interlocks
 - a. Each pump will have a Vacuum Limit Switch (VLS) that will be preset on site during construction to meet each pump's vacuum limit when the suction is restricted. When the VLS is activated the PLC will shut down the associated pump and send a fault signal to the Human Machine Interface (HMI)
 2. All pumps with Emergency Stop Controls (E-STOP) shall immediately cease operation when the E-STOP is activated. All pumps receiving water from the same feature as the pump listed above shall also stop. The PLC shall send a fault signal to the HMI. Operation of associated pumps cannot be continued until the activated E-STOP is reset.
 3. All feature pumps not associated with water treatment shall also have an operator adjustable timer through the PLC to control hours of operation as set by the operator through the HMI.
 - C. Water Filtration System Control
 1. Monitor and control the Water Treatment Pumps and control the position of the Motorized (actuated) Backwash Control Valves
 2. Operation:
 - a. General:
 - i. Provide for MANUAL over-ride mode using the controller to sequence, but the operator shall initiate filter backwash cycles
 - ii. In normal AUTO mode the controller determines when a backwash is necessary, and when it may be allowed
 - b. Backwash Sequencing – Regenerative Media Filters:
 - i. Regenerative Media filters shall include automated regeneration, precoat, and flushing cycle control on each filter tank
 - ii. Controller shall interface with each filter panel to prevent multiple tanks from cycling at the same time
 - c. Backwash Sequencing – Sand Filters:
 - i. Step 1 – Controller monitors treatment pump operation and shuts down treatment pump(s) when backwash is initiated.
 - ii. Step 2 – Controller repositions each of the necessary backwash control valves to allow filter water to flow backwards through the filter at the required flow rate to the waste piping or drain
 - iii. Step 3 – After the valve is repositioned, the controller restarts the treatment pump(s)
 - iv. Step 4 – The backwash priority valve shall remain in its restricting position until all of the filter tanks in a give grouping have been backwashed
 - v. Step 5 – When one tank in a filter grouping has been backwashed for a predetermined time period the controller stops the treatment pump(s) and repositions that tank's backwash valves to normal operating position and the next tank's backwash valves are set to backwash position
 - vi. Step 6 – After the valves have been positioned, treatment pump(s) are restarted. This cycle continues until each of the filter tanks in a giving grouping have been backwashed

- vii. Step 7 – When all filters in a given grouping have been backwashed the controller shall stop the treatment pump(s), return the backwash priority valve to full OPEN position, confirm all valves are in normal operating position and restart the treatment pump(s)

D. Chemical System

- 1. Function: To monitor and control the water pH and ORP of the closed loop water systems
- 2. Operation:
 - a. The chemical controller shall sample and monitor the chemical properties of the system water. The controller shall control the feed pumps to dose liquid chlorine and acid via switching relays in the controller
 - b. The PLC shall monitor treatment pump(s) operation for the system and shall inhibit any chemical injection unless the treatment pump(s) is ON

E. Heater Control

- 1. Function: In addition to normal thermostat control built into the pool heater the PLC shall monitor the temperature of water leaving the mechanical room and insure that the temperature is never more than 104 °F (40 °C)
- 2. Operation:
 - a. The temperature probe shall monitor the temperature of the water going out of the mechanical room and back to the water feature. If the temperature of the water ever exceeds 104 °F (40 °C), the PLC will de-energize the pool heater
- 3. The maximum temperature set point shall be adjustable on the HMI

F. Water Feature Lighting

- 1. Function: To automatically turn the feature lights ON and OFF
- 2. Operation:
 - a. A photocell will be mounted in a remote area adjacent to the associated water feature. The photocell will activate the lights with a relay through the PLC
 - b. Hours of operation may also be programmed into the PLC to switch to a low-light (minimum code requirements) condition during non-operating hours

G. System Alarms and Shutdown Trips

- 1. Mechanical Room High Water Trip
 - a. Function: To monitor high water levels on the mechanical room floor and shutdown electrical power
 - b. Alarm Notification on the door of the Control Panel
 - c. Operation:
 - i. The switch shall be installed near the floor as shown in the contract documents
 - ii. Should the water level switch actuate, the main breaker shall trip de-energizing all water feature equipment within the equipment room
 - iii. Resetting the alarm shall occur when the Motor Control Center (MCC) circuit breaker is reset

H. Pump Restart Time Delay

- 1. Function: To delay restarting all motors and allow a staggered starting after Utility Power Failure
- 2. Operation:
 - a. When the Control Panel is energized, several timing delay relays shall begin timing, each relay shall be set for a five (5) minute cascaded delay

- b. Large pump loads (15 hp and greater) shall not be allowed to start until the time delay for that pump is complete
 - c. The relays shall reset on loss of power at the Control Panel
- I. Motor Control Center (MCC) – Phase Failure Trip
 - 1. Function: To monitor the incoming AC power to the 3-phase MCC, and trip all motors on loss of any phase
 - 2. Operation:
 - a. The Phase Failure relay shall be installed in the MCC monitoring incoming AC power
 - b. Should a low voltage condition on AC power feed occur on any one of three phases, the MCC main circuit breaker shall trip de-energizing the MCC
 - c. There is no indicator or horns for this alarm. Resetting the alarm shall occur when the MCC main circuit breaker is reset

END OF SECTION

SECTION 13 1001 – WATER FEATURE GENERAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Scope of Work
 - 2. Contracts
 - 3. Access to Site
 - 4. Protection of Existing Utilities and Structures
 - 5. Drawings and Specifications
 - 6. Restrictions to the Work

1.2 SCOPE OF WORK

- A. Work to be performed under the Agreement consists of furnishing and installing all materials, equipment systems, and labor required to complete the Work as required by the Contract
- B. Perform the Work in accordance with the codes, ordinances, and amendments in effect in the location of the Project

1.3 CONTRACTS

- A. Perform the Work per the Agreement to be executed between the Owner and the Contractor

1.4 ACCESS TO SITE

- A. During the construction period, the Contractor shall have limited use of the premises for construction operations, including use of the Site. Coordinate site limitations with the Owner
- B. Notify the Owner, city and county agencies, as applicable, a minimum of 48 hours in advance of performing work that necessitates closing or interfering with traffic on public thoroughfares, parking areas, and driveways, or with normal facility operations. Obtain written permission prior to affection such

1.5 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

- A. The Contractor shall verify the location of all existing utilities including cables, conduits, pipes, water lines, gas lines, etc.
- B. The Contractor shall take the proper precautions to avoid damage to such components.
- C. In the event of a conflict or discrepancy, the Contractor shall promptly notify the Owner and Engineer and request for necessary relocation
- D. Failure to follow this procedure, places upon the Contractor the responsibility of making repairs or replace such damage at his own expense
- E. The Contractor shall provide necessary safeguards and exercise caution against damage to existing and new structures, structural components, and finishes. The Contractor shall be responsible for any damages resulting from his operations and shall repair or replace such damage at his own expense

1.6 DRAWINGS AND SPECIFICATIONS

- A. The Contractor is responsible for coordinating all phases of the Work contained within the Contract Documents (W-Series and WE-Series Drawings) with other construction trades and Contract Documents including but not limited to Civil, Structural, Mechanical, Electrical, Plumbing, Architectural, and Landscape trade work
- B. The Contractor is responsible for coordinating the installation and purchase of all the electrical components, including electrical devices, power panels, control panels, motor control centers, etc. as

indicated on the Water Feature Electrical (EW-Series) Drawings for the complete operation of the systems

- C. The Contractor shall notify the Engineer / Architect of any discrepancies, omissions, or conflicts between various elements of the Contract Documents prior to proceeding with any Work involved in the discrepancies, omissions, or conflicts. Generally, the most stringent requirements shall govern the Work

1.7 RESTRICTIONS TO THE WORK

- A. It is required that existing facilities and utilities continue in normal operation during the period of this Agreement
- B. Conduct the Work with a minimum disturbance or interference, and in such a manner as to not restrict or obstruct entrances, exits, passage ways, utility services, or material/supply delivery and pick-up for facility operation

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION

SECTION 13 1101 – WATER FEATURE EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Subsoil Materials
 - 2. Topsoil Materials
 - 3. Structural Fill Materials
 - 4. Aggregate Materials
- B. Related Sections:
 - 1. SECTION 13 1102 – WATER FEATURE GEOSYNTHETICS FOR EARTHWORK
 - 2. SECTION 13 1103 – WATER FEATURE GRADING AND EXCAVATION
 - 3. SECTION 13 1104 – WATER FEATURE DEWATERING
 - 4. SECTION 13 1105 – WATER FEATURE FOUNDATION DRAINAGE
 - 5. SECTION 13 1106 – WATER FEATURE TRENCHING
 - 6. SECTION 13 1107 – WATER FEATURE BACKFILLING
 - 7. SECTION 13 1108 – WATER FEATURE EROSION AND SEDIMENTATION CONTROL
 - 8. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 9. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 10. SECTION 13 1303 – WATER FEATURE MEMBRANE LINER
 - 11. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
- C. References:
 - 1. Site specific Geotechnical Report – Bore Hole Locations and Findings of Subsurface Materials
 - 2. ASTM C136 – STANDARD TEST METHOD FOR SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES
 - 3. ASTM D1556 – STANDARD TEST METHOD FOR DENSITY AND UNIT WEIGHT OF SOIL IN PLACE BY THE SAND-CONE METHOD
 - 4. ASTM D1557 – STANDARD TEST METHOD FOR LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT
 - 5. ASTM D 2167 – STANDARD TEST METHOD FOR DENSITY AND UNIT WEIGHT OF SOIL IN PLACE BY RUBBER BALLON METHOD
 - 6. ASTM D2487 – STANDARD PRACTICE FOR CLASSIFICATION OR SOILS FOR ENGINEERING PURPOSES
 - 7. ASTM D3282 – STANDARD PRACTICE FOR CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES FOR HIGHWAY CONSTRUCTION PURPOSES
 - 8. ASTM D4318 – STANDARD TEST METHODS FOR LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS
 - 9. ASTM D6938 – STANDARD TEST METHOD FOR DENSITY OF SOIL AND SOIL-AGGREGATE IN PLACE BY NUCLEAR METHODS (SHALLOW DEPTH)
 - 10. Standard Specifications for local jurisdictions

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Samples: Provide in air-tight containers, 10 pounds (4.5 kg) of each type of fill material to testing laboratory for evaluation
- C. Material Source: Provide the name of imported materials suppliers and location of the material supplies source
- D. Submit test reports on each type of imported material

1.3 QUALITY ASSURANCE

- A. Perform the Work in accordance with the project specifications and referenced standards. Maintain one (1) copy of the test results on site

1.4 UNIT PRICES – MEASUREMENT AND PAYMENT

- A. Subsoil: By the cubic yard. Includes excavating existing subsoil, supplying subsoil materials, and stockpiling
- B. Topsoil: By the cubic yard. Includes excavating existing topsoil, supplying subsoil materials, and stockpiling

PART 2 - PRODUCTS

2.1 SUBSOIL MATERIALS

- A. Subsoil Type S1: Material Type A-1, A-2-4, A-2-5, and A-3. Conforming with ASTM D3282 (AASHTO M-145) and local jurisdiction engineering standards
- B. Subsoil Type S2:
 - 1. Excavated and reused material, imported borrow, and select or local borrow
 - 2. Graded
 - 3. Free of lumps larger than 3 inches (75mm), rocks larger than 2 inches (50mm), and debris and other organic material
 - 4. Conforming to ASTM D2487 Group Symbol CL OL
 - 5. Containing less than 10 percent material retained on a number 200 sieve

2.2 TOPSOIL MATERIALS

- A. Topsoil Type S3: Conforming to the local jurisdiction's engineering standards, project specifications and references standards
- B. Topsoil Type S4:
 - 1. Excavated and reused material
 - 2. Graded
 - 3. Free of roots, rocks larger than 1 inch (25mm), subsoil, debris, large weeds and foreign matter
 - 4. Conforming to ASTM D2487 Group Symbol
- C. Topsoil Type S5:
 - 1. Imported borrow
 - 2. Friable loam
 - 3. Reasonably free of roots, rocks larger than 1 inch (25mm), subsoil, debris, large weeds, and foreign matter
 - 4. Acidity range (pH) of 5.5 to 7.5
 - 5. Containing a minimum of 4 percent and a maximum of 25 percent inorganic matter
 - 6. Conforming to ASTM D2487 Group Symbol OH PT
 - 7. Limit decaying matter to 10 percent of total content by volume

2.3 COARSE AGGREGATES FOR EARTHWORK

- A. Coarse Aggregates All Types: Conforming to project specifications and referenced standards

- B. Coarse Aggregate Type A (Bedding): Coarse Angular crushed washed stone; free of shale, clay, friable material, and debris; graded in accordance with ASTM C316; within the following limits:

Sieve No. (U.S. Series)	Opening Size inches (mm)	Percent Retained on Sieve (% by Weight)
1 inch	1 (25)	95 to 100
1/2 inch	0.5 (12)	25 to 60
4	0.187 (4.75)	0 to 10
8	0.0937 (2.36)	0 to 5

- C. Aggregate Type B (Pea Gravel): Natural Stone; washed free of clay, shale, organic matter; graded in accordance with ASTM C316, to the following limits

1. Minimum Size: 1/4 inch (6mm)
2. Maximum Size: 5/8 inch (16mm)

2.4 FINE AGGREGATES FOR EARTHWORK

- A. Fine Aggregates Type A5 All Types: Project specifications and referenced standards
- B. Fine Aggregates Type A (Selected Backfill): Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with ASTM C136, within the following limits:

Sieve No. (U.S. Series)	Opening Size inches (mm)	Percent Retained on Sieve (% by Weight)
4	0.187 (4.75)	95 to 100
8	0.0937 (2.36)	85 to 100
16	0.0469 (1.18)	65 to 97
30	0.0234 (0.60)	25 to 70
50	0.0117 (0.30)	5 to 35
100	0.0059 (0.15)	0 to 7
200	0.0029 (0.075)	4 max

2.5 SOURCE QUALITY CONTROL

- A. Conform to Project Quality Control Service specification
- B. Subsoil Materials - Testing and Analysis: Perform in accordance with ASTM D1557 and ASTM D6938
- C. Topsoil Materials - Testing and Analysis: Perform in accordance with ASTM D1557 and ASTM D6938
- D. Coarse Aggregate Materials - Testing and Analysis: Perform in accordance with ASTM D1557, ASTM D2167, ASTM D6938, and ASTM C136
- E. Fine Aggregate Materials - Testing and Analysis: Perform in accordance with ASTM D1557, ASTM D2167, ASTM D6938, and ASTM C136
- F. If test indicate materials do not meet specified requirements, change material and retest
- G. Provide materials of each type from the same source throughout the Work

2.6

PART 3 - EXECUTION

3.1 SOIL REMOVAL

- A. Excavate subsoil and topsoil from areas designated in the Contract Documents
- B. Removed lumped soil, boulders, rock, vegetation, roots, organic matter, muck, and debris

- C. Stockpile excavated material in area designated on site and remove excess material not being used for the site
- D. Excavated material may require sorting and drying
- 3.2 STOCKPILING
 - A. Stockpile materials on site
 - B. Stockpile in sufficient quantities with dividers or stockpile apart to prevent mixing
 - C. Prevent intermixing of soil types or contamination
 - D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials
- 3.3 STOCKPILE CLEAN UP
 - A. Remove stockpile, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water
 - B. If a borrow area is indicated, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water

END OF SECTION

SECTION 13 1102 – WATER FEATURE GEOSYNTHETICS FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Supplying and installation a Geotextile Fabric Under-Liner
- B. Related Sections:
 - 1. SECTION 13 1101 – WATER FEATURE EARTHWORK
 - 2. SECTION 13 1103 – WATER FEATURE GRADING AND EXCAVATION
 - 3. SECTION 13 1104 – WATER FEATURE DEWATERING
 - 4. SECTION 13 1105 – WATER FEATURE FOUNDATION DRAINAGE
 - 5. SECTION 13 1106 – WATER FEATURE TRENCHING
 - 6. SECTION 13 1107 – WATER FEATURE BACKFILLING
 - 7. SECTION 13 1108 – WATER FEATURE EROSION AND SEDIMENTATION CONTROL
 - 8. SECTION 13 1303 – WATER FEATURE MEMBRANE LINER
 - 9. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
- C. References:
 - 1. ASTM D3786 – STANDARD TEST METHOD FOR BURSTING OF TEXTILE FABRICS-DIAPHRAGM BURSTING STRENGTH TESTER METHOD
 - 2. ASTM D4355 – STANDARD TEST METHOD FOR DETERIORATION OF GEOTEXTILE BY EXPOSURE TO LIGHT, MOISTURE AND HEAT IN A XENON ARC TYPE APPARATUS
 - 3. ASTM D4491 – STANDARD TEST METHODS FOR WATER PERMEABILITY OF GEOTEXTILES BY PERMITIVITY
 - 4. ASTM D4533 – STANDARD TEST METHOD FOR TRAPEZOID TEARING STRENGTH OF GEOTEXTILES
 - 5. ASTM D4632 – STANDARD TESTING METHOD FOR GRAB BREAKING LOAD AND ELONGATION OF GEOTEXTILES
 - 6. ASTM D4751 – STANDARD TEST METHOD FOR DETERMINING APPARENT OPENING SIZE OF A GEOTEXTILE
 - 7. ASTM D4833 – STANDARD TEST METHOD FOR INDEX PUNCTURE RESISTANCE OF GEOMEMBRANES AND RELATED PRODUCTS
 - 8. ASTM D5199 – STANDARD TEST METHOD FOR MEASURING THE NOMINAL THICKNESS OF GEOSYNTHETICS
 - 9. ASTM D5261 – STANDARD TEST METHOD FOR MEASURING MASS PER UNIT AREA OF GEOTEXTILES

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's literature, application instructions, and product test reports
- C. Sample: Provide four (4) 12 by 12 inch (300 by 300mm) square samples
- D. Warranty: Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer.

1.3 QUALITY ASSURANCE

- A. Installer Experience: Company specializing in performing the work of this section with minimum of five years experience and approved by the manufacturer

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The Fabric Under-Liner shall be a non-woven geotextile fabric. The Fabric shall have the following minimum properties

Properties (Units)	Test Method	Value
Grab Tensile Strength (lb / kg)	ASTM D4632	350 / 160
Elongation (%)	ASTM D4632	50
Trapezoid Tear (lb / kg)	ASTM D4533	110 / 50
Puncture (lb / kg)	ASTM D4833	190 / 86
Mullen Burst (psi / MPa)	ASTM D3786	700 / 4.8
Permeability Coefficient (cm/sec)	ASTM D4491	0.1
Apparent Opening Size	ASTM 4751	100+
Weight (oz/sq yd / g/sq. m)	ASTM 5261	16 / 543
Thickness (mils / mm)	ASTM D5199	180 / 4.6
Vertical Water Flow Rate (gpm/sq ft / lpm/sq. m)	ASTM D4491	50 / 2000
Ultraviolet (UV) Resistance (%)	ASTM D4355	70

- B. Packaging:

1. Roll Width: 16 feet (5m) minimum
2. Roll Length: 328 feet (100m) minimum

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Geotextile fabric shall be installed by laying fabric on a prepared surface to the limits of all lakes, water features, ponds, waterfalls, and cascades
- B. Geotextile fabric shall have sufficient excess around the perimeter to underlay the entire membrane liner as shown on the Contract Documents
- C. Geotextile fabric shall be placed with a minimum of 8 inches (200mm) of overlap at all longitudinal seams and 20 inches (500mm) of overlap at all transverse seams
- D. After membrane liner is installed, a second Geotextile Fabric shall be overlaid with sufficient excess around the perimeter to cover the entire membrane liner to protect the liner during placement of the steel reinforcement and water feature concrete shell

END OF SECTION

SECTION 13 1103 – WATER FEATURE GRADING AND EXCAVATION

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Removal of Topsoil and Subsoil
 - 2. Cutting, grading, filling, rough contouring, compacting, and shaping the site for water features and associated mechanical buildings and a structures
 - 3. Excavating for foundations
 - 4. Excavating for slabs-on-grade, paving, and landscaping
 - 5. Excavating for site structures
- B. Related Sections:
 - 1. SECTION 13 1101 – WATER FEATURE EARTHWORK
 - 2. SECTION 13 1102 – WATER FEATURE GEOSYNTHETICS FOR EARTHWORK
 - 3. SECTION 13 1104 – WATER FEATURE DEWATERING
 - 4. SECTION 13 1105 – WATER FEATURE FOUNDATION DRAINAGE
 - 5. SECTION 13 1106 – WATER FEATURE TRENCHING
 - 6. SECTION 13 1107 – WATER FEATURE BACKFILLING
 - 7. SECTION 13 1108 – WATER FEATURE EROSION AND SEDIMENTATION CONTROL
 - 8. SECTION 13 1303 – WATER FEATURE MEMBRANE LINER
 - 9. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
- C. References:
 - 1. ASTM C136 – STANDARD TEST METHOD FOR SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES
 - 2. ASTM D1556 – STANDARD TEST METHOD FOR DENSITY AND UNIT WEIGHT OF SOIL IN PLACE BY THE SAND-CONE METHOD
 - 3. ASTM D1557 – STANDARD TEST METHOD FOR LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT
 - 4. ASTM D2167 – STANDARD TEST METHOD FOR DENSITY AND UNIT WEIGHT OF SOIL IN PLACE BY RUBBER BALLON METHOD
 - 5. ASTM D2419 – STANDARD TEST METHOD FOR SAND EQUIVALENT VALUE OF SOILS AND FINE AGGREGATE
 - 6. ASTM D2434 – STANDARD TEST METHOD FOR PERMEABILITY OF GRANULAR SOILS (CONSTANT HEAD)
 - 7. ASTM D6938 – STANDARD TEST METHOD FOR DENSITY OF SOIL AND SOIL-AGGREGATE IN PLACE BY NUCLEAR METHODS (SHALLOW DEPTH)

1.1 UNIT PRICE – MEASUREMENT AND PAYMENT

- A. Miscellaneous Fill: By the cubic yard (meter). Includes excavating existing soil, supplying soil materials, stockpiling, scarifying substrate surfaces, placing where required, and compacting
- B. Structural Fill Type A: By the cubic yard (meter). Includes excavating existing soil, supplying structural fill materials, stockpiling, scarifying substrate surfaces, placing where required, and compacting

1.2 QUALITY ASSURANCE

- A. Perform the Work in accordance with the project specifications and referenced standards. Maintain one (1) copy of the test results on site

1.3 PROJECT RECORD DOCUMENTS

- A. Submit as per Project Specifications

- B. Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Topsoil: As specified in Section 13 1101 – WATER FEATURE EARTHWORK
- B. Subsoil: As specified in Section 13 1101 – WATER FEATURE EARTHWORK
- C. Structural Fill: As specified in Section 13 1101 – WATER FEATURE EARTHWORK

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Verify site conditions prior to beginning the Work
- B. Verify that survey benchmarks and intended elevations for the Work are as indicated in the Contract Documents

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum
- B. Stake and flag locations of known utilities
- C. Locate, identify, and protect utilities that remain from excavation and grading activities
- D. Notify all utility companies to remove and relocate utilities
- E. Protect above and below grade utilities that remain
- F. Protect plant life, lawns, and other features remaining as a portion of final landscaping
- G. Protect Benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic

3.3 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded
- B. Do not excavate wet subsoil or excavate and process wet material in an attempt to obtain optimum moisture content
- C. When excavating through roots, perform the Work by hand and cut roots with a sharp axe
- D. Stockpile in area designated on site to depth on exceeding and protect from erosion. Remove from subsoil not being used from the site
- E. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key placed fill material to slope to provide firm bearing
- F. Stability: Replace damaged or displaced subsoil to the same requirements as specified for fill

3.4 EXCAVATION

- A. Underpin adjacent structures that may be damaged by excavating Work
- B. Excavate subsoil to accommodate building foundations, slabs-on-grade, paving, site structures, utilities or other construction operations, and to the elevation and dimensions indicated on the Contract Documents
- C. When excavation has reached required subgrade elevations, notify the Owner, who will make an inspection of conditions. Do not excavate below indicated depth unless directed by the Owner or Owner Representative

- D. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity or to a minimum of 3,000 psf (144 kPa) or 4,000 psf (192 kPa) as indicated on the Contract Documents;
perform compaction in accordance with Section 31 23 33.13 and 31 23 33.16
- E. If inspection indicates unsuitable material and conditions, additional excavation and corrective Work shall be performed as directed by the Owner
- F. Slope banks with machine to angle of repose or less until shored
- G. Do not interfere with 45 degree bearing splay of foundations
- H. Grade top perimeter of excavating to prevent surface water from draining into excavation
- I. Hand trim excavation. Remove loose material
- J. Notify Architect/Engineer of unexpected subsurface conditions and discontinue affected Work in the area until notified to resume Work

K. Correct areas over excavated in accordance with Section 31 23 33.16

3.5 FILLING

- A. Install the Work in accordance with Project specifications and referenced standards
- B. Fill areas to proposed contours and elevations with appropriate fill materials
- C. Place fill material in continuous layers and compact to attain required compaction density
- D. Slope grade away from buildings at a minimum of 2 inches (50mm) in 10 feet (3m), unless otherwise noted
- E. Make grade changes gradual. Blend slope into level areas
- F. Remove surplus fill material from the site

3.6 TOLERANCES

- A. Top surface of subgrade shall be plus or minus 1 foot (300mm) from required elevation

3.7 FIELD QUALITY CONTROL

- A. Comply with the requirements of the Project specifications and referenced standards
- B. Perform excavation Work in compliance with applicable requirements of governing authorities and codes having jurisdiction
- C. Testing shall be in accordance with ASTM D1556, ASTM D1557, ASTM D2167, and ASTM D6938
- D. If testing indicates that the Work does not meet specified requirements, remove Work, replace, and retest
- E. Frequency of Tests: Test upper 12 inches (300mm) as recommended by the Project Geotechnical Engineer

3.8 SCHEDULES

- A. Conform to the Project specification and referenced standards
- B. Structural Fill for Building Pads:
 - 1. Fill shall consist of clean sand that is free of organic matter and other deleterious substances. It shall have a fines content that does not exceed 15 percent. Maximum compacted depth shall be 8 inches (200mm)
- C. Subsoil Fill:
 - 1. Fill Type S1: Maximum compacted depth shall be 8 inches (200mm)

2. Compact to minimum 98 percent of maximum density
- D. Topsoil Fill:
 1. Fill Type S2: Maximum compacted depth shall be 8 inches (200mm)
 2. Compact to minimum 95 percent of maximum density
- 3.9 PROTECTION
 - A. Prevent displacement or loose soil from falling into excavation, maintain soil stability
 - B. Protect bottom of excavations and soil adjacent to and beneath foundations from damage caused by settlement, lateral movement, undermining, washout and other hazards caused by earthwork operations
 - C. Provide warning lights, DANGER or CAUTION signs and watchmen at all places where excavation constitutes, in any way, a hazard to any persons whose injuries might result from the failure to take such precautions
 - D. The Contractor shall take any measures necessary to ensure the safety of workers and others present on the job site throughout the contract period. This shall include, but is not limited to, conforming with all applicable OSHA regulations, as well as, the rules of the regulatory agencies with proper jurisdiction

END OF SECTION

SECTION 13 1105 – WATER FEATURE FOUNDATION DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Building perimeter, retaining walls, and under slab-on-fill weep drainage systems
 - 2. Filter drainage systems
- B. Related Sections:
 - 1. SECTION 13 1101 – WATER FEATURE EARTHWORK
 - 2. SECTION 13 1102 – WATER FEATURE GEOSYNTHETICS FOR EARTHWORK
 - 3. SECTION 13 1103 – WATER FEATURE GRADING AND EXCAVATION
 - 4. SECTION 13 1104 – WATER FEATURE DEWATERING
 - 5. SECTION 13 1106 – WATER FEATURE TRENCHING
 - 6. SECTION 13 1107 – WATER FEATURE BACKFILLING
 - 7. SECTION 13 1108 – WATER FEATURE EROSION AND SEDIMENTATION CONTROL
 - 8. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 9. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 10. SECTION 13 1303 – WATER FEATURE MEMBRANE LINER
 - 11. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
- C. References:
 - 1. AASHTO M 252 – STANDARD SPECIFICATION FOR CORRUGATED POLYETHYLENE DRAINAGE PIPE
 - 2. AASHTO M 294 – STANDARD SPECIFICATION FOR CORRUGATED POLYETHYLENE DRAINAGE PIPE, 300- TO 1500-mm DIAMETER
 - 3. ASTM D543 – STANDARD PRACTICES FOR EVALUATING THE RESISTANCE OF PLASTICS TO CHEMICAL REAGENTS
 - 4. ASTM D2665 – STANDARD SPECIFICATION FOR POLY(VINYL CHLORIDE) (PVC) PLASTIC DRAIN, WASTE AND VENT PIPE AND FITTINGS
 - 5. ASTM F405 – STANDARD SPECIFICATION FOR CORRUGATED POLYETHYLENE (PE) TUBING AND FITTINGS
 - 6. ASTM F449 – STANDARD PRACTICE FOR SUBSURFACE INSTALLATION OF CORRUGATED POLYETHYLENE PIPE FOR AGRICULTURAL DRAINAGE OR WATER TABLE CONTROL
 - 7. ASTM F667 – STANDARD SPECIFICATION FOR LARGE DIAMETER CORRUGATED POLYETHYLENE PIPE AND FITTINGS

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's data on pipe drainage products, pipe accessories, including hydraulic, structural, and installation recommendations

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

- A. Acceptable Manufacturers
 - 1. Advanced Drainage Systems: Model N12
 - 2. Approved Equal
- B. Corrugated High Density Polyethylene Pipe (CPEP): ASTM F405; plain end, 4 and 6 inch (100 and 150mm) inside diameter with required fittings

- C. Polyvinyl Chloride Pipe (PVC): ASTM D2665; plain end, 4 and 6 inch (100 and 150mm) inside diameter with required fittings
- D. Use perforated pipe at subdrainage system; unperforated through sleeved walls
- 2.2 AGGREGATE AND BEDDING
 - A. Filter Aggregate and Bedding Materials: Fill Type B as specified in SECTION 13 1101 – WATER FEATURE EARTHWORK
 - B. Pipe Coupling: Solid
 - C. Filter Fabric: Water pervious type, black polyester or nylon where indicated on the Contract Documents

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Verify that the excavated base is ready to receive Work and excavations, dimensions, and elevations as indicated on the Contract Documents
- 3.2 PREPARATION
 - A. Hand trim excavated to required elevations
 - B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction
 - C. Lay pipe to slope gradients noted on the Contract Documents; with maximum variation from true slope of 1/8 inch (3mm) in 10 feet (3m)
 - D. Loosely butt pipe ends. Place joints covers around pipe diameter centered over joint
 - E. Install pipe couplings
 - F. Install Type B aggregates at sides, over joint covers, and top of pipe. Provide top cover compacted thickness of 12 inches (300mm)
 - G. Place filter fabric over leveled top surface of aggregate cover prior to subsequent backfilling operations
 - H. Place aggregate in maximum 6 inch (150mm) lifts, consolidating each lift
 - I. Refer to SECTION 31 23 33.13 for compaction requirements. Do not displace or damage pipe when compacting
 - J. Connect to storm sewer system with unperforated pipe
- 3.3 FIELD QUALITY CONTROL
 - A. Comply with Project specifications and referenced sections
 - B. Request inspection prior to and immediately after placing aggregate cover over pipe
- 3.4 PROTECTION
 - A. Protect pipe and aggregate cover from damage or displacement until backfilling operations begins
- 3.5 SCHEDULE
 - A. Perimeter Drainage: At building wall perimeter, inside wall foundation, and surrounding pit foundation walls; and perimeter of concrete lagoon shell as indicated on the Construction Documents

END OF SECTION

SECTION 13 1106 – WATER FEATURE TRENCHING

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Excavating Trenches for piping from 5 feet (1.5m) outside building to project limits
 - 2. Compacted fill from top of pipe bedding to subgrade elevations
 - 3. Backfilling and Compaction
- B. Related Sections:
 - 1. SECTION 13 1101 – WATER FEATURE EARTHWORK
 - 2. SECTION 13 1102 – WATER FEATURE GEOSYNTHETICS FOR EARTHWORK
 - 3. SECTION 13 1103 – WATER FEATURE GRADING AND EXCAVATION
 - 4. SECTION 13 1104 – WATER FEATURE DEWATERING
 - 5. SECTION 13 1105 – WATER FEATURE FOUNDATION DRAINAGE
 - 6. SECTION 13 1107 – WATER FEATURE BACKFILLING
 - 7. SECTION 13 1108 – WATER FEATURE EROSION AND SEDIMENTATION CONTROL
 - 8. SECTION 13 1303 – WATER FEATURE MEMBRANE LINER
 - 9. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
 - 10. Project Specifications for Coordinated Work
- C. References:
 - 1. Site specific Geotechnical Report – Bore Hole Locations and Findings of Subsurface Materials
 - 2. ASTM C136 – STANDARD TEST METHOD FOR SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES
 - 3. ASTM D1556 – STANDARD TEST METHOD FOR DENSITY AND UNIT WEIGHT OF SOIL IN PLACE BY THE SAND-CONE METHOD
 - 4. ASTM D1557 – STANDARD TEST METHOD FOR LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING MODIFIED EFFORT
 - 5. ASTM D 2167 – STANDARD TEST METHOD FOR DENSITY AND UNIT WEIGHT OF SOIL IN PLACE BY RUBBER BALLON METHOD
 - 6. ASTM D6938 – STANDARD TEST METHOD FOR DENSITY OF SOIL AND SOIL-AGGREGATE IN PLACE BY NUCLEAR METHODS (SHALLOW DEPTH)
 - 7. Standard Specifications for local jurisdictions

1.2 UNIT PRICE – MEASUREMENT AND PAYMENT

- A. Excavating Subsoil Materials: By the cubic yard (meter). Includes general excavation to required elevation, loading and placing materials in stockpile and removing from the site.
- B. Over Excavating: Payment is not made for over excavation work nor for replacement materials

1.3 DEFINITIONS

- A. Utility: Any buried, pipe, duct, conduit, or cable

1.4 FIELD MEASUREMENTS

- A. Verify that survey bench marks, control points, and intended elevations for the Work are as shown on the Contract Documents

1.5 COORDINATION

- A. Coordinate the Work as per the Project Specifications and referenced sections
- B. Verify the Work associated with lower elevation utilities is complete before placing higher elevation utilities

- C. The Contractor shall coordinate the installation of all utility Work with the water feature Work
- D. It is the responsibility of the Contractor to make all connections to Work that is already in place and to coordinate such connections with all other parties

PART 2 - PRODUCTS**2.1 FILL MATERIALS**

- A. Fill Type S1: As specified in SECTION 13 1101 – WATER FEATURE EARTHWORK
- B. Structural Fill Type A: As specified in SECTION 13 1101 – WATER FEATURE EARTHWORK
- C. Concrete: Lean concrete conforming to SECTION 03 3000 – STRUCTURAL CONCRETE Type C with a compressive strength of 2,500 psi (11.9 kPa)

2.2 ACCESSORIES

- A. Geotextile Fabric: As specified in SECTION 13 1102 – WATER FEATURE GEOSYNTHETICS FOR EARTHWORK
- B. Filter Fabric: As specified in SECTION 13 1105 – WATER FEATURE FOUNDATION DRAINAGE

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Identify required lines, levels, contours, and datum locations
- B. Protect plant life, improvements, and other on-site feature to remain as a portion of the final landscaping
- C. Protect bench marks, existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic
- D. Maintain and protect above and below grade utilities
- E. Cut out soft areas of subgrade not capable of compaction in place. Backfill with coarse aggregate (Type A) and compact to a density equal or greater than requirements for subsequent backfill material

3.2 EXCAVATING

- A. Excavating subsoil required for utilities in accordance with local governing agencies requirements
- B. Cut Trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with the Work
- C. Do not interfere with the 45 degree bearing splay of foundations
- D. Hand trim excavations. Hand trim for bell and spigot pipe joints. Remove loose matter
- E. Correct areas over excavated in accordance with SECTION 31 2316
- F. Stockpile excavated material in area designated on site and remove excess material not being reused from the site
- G. The execution and preparation of trenches shall not proceed in advance of pipe installation more than 50 feet (15m), except as approved by the Owner. Trenching shall not, under any conditions, exceed the quantity of pipe that can be bedded, inspected, tested, backfilled and compacted in one (1) working day
- H. Excavation in close proximity to existing utilities shall be performed in such a manner so as to prevent damage to the utilities
- I. The sides of trenches shall be kept as nearly vertical as possible from the trench bottom to a level 12 inches (300mm) above the top of pipe

- J. The trench bottom shall be associated to true line and grade and shall not be less than 24 inches (600mm) wide, nor more than 24 inches (600mm) wider than the outside diameter of the pipe, so that a clean space from 9 to 12 inches (225 to 300mm) is provided on each side of the pipe
 - K. The Contractor shall furnish, install, and maintain sheeting, bracing, and shoring as required to support the sides of the excavation, and to prevent any movement that may damage adjacent utilities, or structures, damage or delay the Work, or endanger life and health. All voids outside the supports shall be immediately filled and compacted
- 3.3 BACKFILLING
- A. Backfill trenches to the contours and to the elevations indicated on the Contract Documents with unclassified fill materials
 - B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces
 - C. Coarse Aggregate (Type A): Place and compact materials in equal continuous layers not exceeding 8 inches (200mm) compacted depth
 - D. Unclassified Fill: Place and compact materials in equal continuous layers not exceeding 8 inches (200mm) compacted depth
 - E. Employ a placement method that does not disturb or damage foundation perimeter drainage, or utilities in the trench
 - F. Maintain optimum moisture content of each layer of fill materials to attain required compaction density. Add water by uniform sprinkling
 - G. Remove surplus fill materials from the site
 - H. Leave fill material stockpile areas completely free of excess fill materials
- 3.4 TOLERANCES
- A. Top Surface of Backfilling under Paved Areas: Plus or minus 0.04 feet (12mm) from required elevations
 - B. Top Surface of General Backfilling: Plus or minus 0.08 feet (25mm) from required elevations
- 3.5 FIELD QUALITY CONTROL
- A. Comply with Project Specifications and referenced sections
 - B. Compaction testing shall be performed in accordance with ASTM D1556, ASTM D1557, ASTM D2167, and ASTM D6938
 - C. If testing indicate that the Work does not meet specified requirements, remove the Work, replace, compact, and retest
 - D. Frequency of Tests: one (1) test per 100 feet (30m) of trench
- 3.6 PROTECTION OF FINISHED WORK
- A. Protect finished work as per the Project Specifications and referenced sections
 - B. Reshape and re-compact fills subjected to vehicular traffic during construction
- 3.7 SCHEDULE
- A. Water Feature Piping: Cover pipe and bedding with Type S2, in 8 inch (200mm) lifts, compacted to 95 percent

END OF SECTION

SECTION 13 1108 – WATER FEATURE EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Erosion and Sedimentation Control Requirements for:
 - a. Features in Place prior to construction
 - b. Location in accordance with Contract Documents or as required
 - c. Control Features
- B. Related Sections:
 - 1. SECTION 13 1101 – WATER FEATURE EARTHWORK
 - 2. SECTION 13 1102 – WATER FEATURE GEOSYNTHETICS FOR EARTHWORK
 - 3. SECTION 13 1103 – WATER FEATURE GRADING AND EXCAVATION
 - 4. SECTION 13 1104 – WATER FEATURE DEWATERING
 - 5. SECTION 13 1105 – WATER FEATURE FOUNDATION DRAINAGE
 - 6. SECTION 13 1106 – WATER FEATURE TRENCHING
 - 7. SECTION 13 1107 – WATER FEATURE BACKFILLING
- C. References:
 - 1. ASTM D5034 – STANDARD TEST METHOD FOR BREAKING STRENGTH AND ELONGATION OF TEXTILE FABRICS (GRAB TEST)
 - 2. ASTM D5035 – STANDARD TEST METHOD FOR BREAKING FORCE AND ELONGATION OF TEXTILE FABRICS (STRIP METHOD)
 - 3. ASTM D5141 – STANDARD TEST METHOD FOR DETERMINING FILTERING EFFICIENCY AND FLOW RATE OF THE FILTRATION COMPONENT OF A SEDIMENT RETENTION DEVICE
 - 4. Local Governing Agency requirements and standard practices for Sedimentation Control

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's literature, application instructions and samples
 - 1. List of materials and their characteristics for other erosion control items
 - 2. Geotextile Fabric specification from the Manufacturer
 - 3. Installation Configuration of Geotextile Fabric
- C. Shop Drawings: Submit an Erosion Control Plan for approval by local governing agencies prior to implementation

1.3 QUALITY ASSURANCE

- A. The provision for prevention, control, and abatement of erosion, sedimentation, and water pollution shall be stated in the following documents:
 - 1. Local Governing Agencies Permit Requirements
 - 2. Local Governing Agencies Engineering Standards Manual

1.4 CONTROL OF CONTRACTOR'S OPERATION THAT MAY RESULT IN WATER POLLUTION

- A. The Contractor shall take sufficient precautions to prevent pollution of streams, canals, lakes, reservoirs, wetlands, and other sensitive areas
- B. Types of Pollution not permitted include:
 - 1. Silt

2. Sediment
 3. Fuels
 4. Oils
 5. Bitumen
 6. Calcium Chloride
 7. Other harmful materials
- C. Conduct and schedule operations so as to avoid or otherwise minimize pollution or siltation of water bodies
 - D. Avoid interferences with movement of migratory fish
 - E. Do not dump the residue from dust collectors or washers into any water body
 - F. Construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals, and other impoundments shall be restricted to the following:
 1. Areas where it is necessary to perform filling or excavation to accomplish the Work shown in the Contract Documents
 2. Areas that must be entered to construct temporary or permanent structures
 - G. As soon as conditions permit, clear rivers, streams, and impoundments of all obstructions placed therein or cause by construction operations
 - H. Except as necessary for construction, do not deposit excavated material in rivers, streams, canals, or impoundments
 - I. Do not deposit excavated material close enough to water bodies to be washed away by high water runoff
 - J. Where pumps are used to remove highly turbid waters from enclosed construction areas, such as cofferdams or forms, treat the water prior to discharge into local waters
 - K. Pump the water into grassed swells, appropriately vegetated areas, or sediment basins, or confine water by an appropriate enclosure, such as siltation curtains
 - L. Do not contaminate local waters
 - M. The background condition of all waters to be discharged from the site must be tested by the Contractor prior to discharge
 - N. Do not disturb lands or waters outside the limits of construction, unless approved in advanced and in writing by the Owner
 - O. No operations with non-permitted wetlands or upland buffers are allowed
- 1.5 START OF WORK
- A. Do not start Work until erosion control measures are in place

PART 2 - PRODUCTS

2.1 SILT BARRIERS

- A. Install silt barriers and floating silt barriers in accordance with the Contract Documents
- B. Silt barriers (filter fabric) shall be synthetic and contain ultraviolet (UV) ray inhibitors and stabilizers to provide a minimum of six (6) months of expected usable construction life at a temperature range between 0 and 120 °F (-17.8 to 48.9 °C)
- C. Filter fabric shall be pervious sheet of propylene, nylon, or polyester and shall be certified by the Manufacturer or Supplier to conform to the following specification:
 1. Filter Efficiency (ASTM D5141): 75%

2. Minimum Tensile Strength at 20% Elongation (ASTM D5034): 120 pounds (54.4 kg)
3. Tear Strength (ASTM D5035): 50 pounds (22.6 kg)
- D. The Contractor shall submit filter fabric material specification and installation configuration to start construction
- E. Silt Barriers shall be maintained in place and shall be removed upon completion of permanent erosion control measures
- F. Filter Fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid to the use of joints
- G. When joints are necessary, filter fabric shall be spliced together only at a support post, with a 6 inch (150mm) overlap, and securely sealed
- H. The following items shall be installed and maintained in accordance with applicable section of the local governing agencies Engineering Standards Manual:
 1. Temporary silt fences and staked silt barriers
 2. Floating silt barriers

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Temporary erosion control features shall consist of the following:
 1. Temporary grassing
 2. Temporary mulching
 3. Sandbagging
 4. Slope Drains
 5. Sediment Basins
 6. Artificial Coverings
 7. Berms
 8. Baled Hay or Straw
 9. Floating Silt Barriers
 10. Staked Silt Barriers and Stake Silt Fences
- B. Design details for some of these Erosion Control Features can be found in the local governing agency's Engineering Standards Manual
- C. All of these control features shall be constructed in accordance with applicable sections of the local governing agency's specifications
- D. Incorporate permanent Erosion Control Features into the project at the earliest practical time
- E. Correct conditions, using temporary measures that develop during construction to control erosion prior to the time it is practical to construct permanent control features
- F. Construct temporary and permanent Erosion and Sediment Control measures and maintain them to prevent the pollution of adjacent water ways
- G. Copies of approved permits will be provided to the Contractor for his review and use
- H. The Contractor is required to comply with all General and Special Conditions noted within the permit by the particular permitting agency
- I. Maintain copies of these permits on the job site at all times

3.2 INSTALLATION

- A. The following shall be installed as per the local governing agency's Standard Specification for Road, Bridge, and Utility Construction as required to control erosion and sedimentation:

1. Temporary grassing: This Work shall consist of furnishing and placing grass seed
2. Temporary sod: This Work shall consist of furnishing and placing sod
3. Temporary Mulching
 - a. Apply a 2 to 4 inch (50 to 100mm) thick blanket of straw or hay mulch
 - b. Mix or force the mulch into the top 2 inches (50mm) of the soil in order to temporarily control erosion
 - c. Use only undecayed straw or hay, which can be readily cut into the soil
 - d. Other measures for temporary erosion control such as hydro-mulching, chemical adhesive, soil stabilizers, etc. can be substituted for mulching the straw or hay with the approval of the Owner
 - e. When permanent grassing operations begin, temporary mulch materials shall be plowed under in conjunction with preparation of the ground
4. Sandbagging: Furnish and place sandbags in configurations, so as to control erosion and siltation
5. Slope Drains:
 - a. Construct slope drains, utilizing pipe, fiber mats, rubble, cement concrete, asphaltic concrete, plastic sheeting, or other acceptable materials
 - b. Construct in accordance with the local governing agency's Standard Specification and Details
6. Sediment Basins
 - a. Construct in accordance with the local governing agency's Standard Specification and Details
 - b. Sediment Basins shall be cleaned out as necessary
7. Artificial Coverings: This Work shall consist of furnishing and applying fiber mats, netting, plastic sheeting, or other approved covering to the earth surface
8. Berms:
 - a. Construct temporary earth berms to divert flow of water from an erodible surface
 - b. Construct dams of bailed hay, straw, or earth to protect against downstream accumulations of silt
 - c. The berm or dam shall be placed so as to effectively control silt dispersions under conditions present
 - d. Construct in accordance with the local governing agency's Standard Specification and Details
 - e. Alternate solutions and usage of materials may be used if approved by the Owner

3.3 SILT BARRIERS

- A. Silt Barriers shall be installed and maintained at the perimeter of the site and/or as otherwise shown on the Contract Documents
- B. Prevent the possibility of silting onto adjacent parcel
- C. Silt Barrier shall be of the staked type and stake shall be installed as detailed in the Contract Documents or local governing agency's standards
- D. The stakes shall be 2 by 4 inch (50 by 100mm) wood, 5 feet (1.5m) long and shall be space a maximum of 10 feet (3m) apart at the barrier location and driven securely into the ground
- E. The height of the Silt Barrier fabric shall be a minimum of 42 inches (1.1m)
- F. The trench shall be excavated approximately 4 inches (100mm) wide by 4 inches (100 by 100mm) deep along the line of the stakes
- G. The staples shall be heavy duty wire and at least 1/2 inch (12mm) long

- H. The filter fabric shall be tied or stapled to the wooden stakes and 8 inches (200mm) of fabric shall be extended into the trench
- I. The trench shall then be backfilled and the soil compacted over the filter fabric
- 3.4 FLOATING SILT BARRIERS
 - A. Floating Silt Barrier shall be located as shown on the Contract Documents and shall be placed prior to the start of any construction or grading
 - B. Floating Silt Barriers shall meet or exceed the recommendation of the local governing agency's standard details
- 3.5 TEMPORARY FENCE
 - A. Furnish, install, and maintain temporary fences on all wetland lines, buffer lines, tree save lines and as otherwise shown on the Contract Documents
 - B. Follow Manufacturer's installation recommendations
- 3.6 MAINTENANCE
 - A. Silt Barriers and Temporary Fences shall be inspected immediately after each rainfall
 - B. Inspect Temporary Fences at least once a day during periods of prolonged rainfall
 - C. Make repairs immediately
 - D. Should the fabric on a Silt Barrier or Temporary Fence decompose or become ineffective, the installation shall be repaired or replaced immediately
 - E. If the Contractor fails to repair or replace the items above the local governing agency shall have the right to stop work without additional cost to the Owner until the repair or replacement has been made
 - F. Sediment deposits shall be removed after each storm event
 - G. The Contractor will repair and restore the installation to a working effective condition as required by applicable local governing agency's requirements and/or permit requirements
 - H. At the completion of all Work, the Silt Barriers and Temporary Fences will be removed and disposed of by the Contractor as directed by the Owner
 - I. Any sediment deposits in place after the Silt Barrier or filter barrier is no longer required shall be dressed to conform to existing grade and prepared for seeding or sod
- 3.7 PROTECTION DURING SUSPENSION OF CONTRACT TIME
 - A. If construction operations are suspended for any appreciable length of time, perform the following operation:
 - 1. Shape the top of the earthwork in such a manner as to permit runoff water
 - 2. Construct earth berms along the top edges of embankments to intercept runoff water
 - 3. Provide temporary slope drains to carry runoff from cuts and embankments that are located in the vicinity of rivers, streams, canals, lakes, and impoundments
 - 4. Should such preventative measures fail, immediately take such other actions as necessary to effectively prevent erosion and siltation

END OF SECTION

SECTION 13 1202 – WATER FEATURE STEEL REINFORCEMENT

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Reinforcing Steel Bars
 - 2. Wire Fabric
 - 3. Expanded Metal Lath
 - 4. Reinforcing Fibers
 - 5. Supports and Accessories
- B. Related Sections:
 - 1. SECTION 13 1203 – WATER FEATURE CONCRETE FORMWORK
 - 2. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 3. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 4. SECTION 13 1611 – WATER FEATURE GROUNDING
- C. References:
 - 1. ACI 301-05 – STANDARD SPECIFICATIONS FOR STRUCTURAL CONCRETE
 - 2. ACI 318-05 – BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE
 - 3. ACI SP-4 – AMERICAN CONCRETE INSTITUTE DETAILING MANUAL
 - 4. ASTM A82/A83-07 – COLD DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT
 - 5. ASTM A184-02 – FABRICATED DEFORMED STEEL BAR MATS FOR CONCRETE REINFORCEMENT
 - 6. ASTM A185-02 – WELDED STEEL WIRE FABRIC FOR CONCRETE REINFORCEMENT
 - 7. ASTM A496-02 – DEFORMED STEEL WIRE FABRIC FOR CONCRETE REINFORCEMENT
 - 8. ASTM A497-01 – WELDED DEFORMED STEEL WIRE FABRIC FOR CONCRETE REINFORCEMENT
 - 9. ASTM A615-04 – DEFORMED AND PLAIN BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT
 - 10. ASTM A706/706M-04 – LOW-ALLOY STEEL DEFORMED BARS FOR CONCRETE REINFORCEMENT
 - 11. ASTM A775/775M-04 – EPOXY COATED REINFORCING STEEL BARS
 - 12. ASTM C847-00 – GALVANIZED FINISH
 - 13. ASTM D3963 – EPOXY COATED REINFORCING STEEL
 - 14. AWS D1.4-04 – STRUCTURAL WELDING CODE FOR REINFORCING STEEL
 - 15. CRSI – CONCRETE REINFORCING STEEL INSTITUTE – MANUAL OF STANDARD PRACTICE
 - 16. CRSI 63 – RECOMMENDED PRACTICE FOR PLACING REINFORCING BARS
 - 17. CRSI 65 – RECOMMENDED PRACTICE FOR PLACING BAR SUPPORTS, SPECIFICATIONS, AND NOMENCLATURE

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit manufacturer's literature and material specification on reinforcement support, chairs, bolsters, spacers, etc. indicating type and location for use. Only approved supports and methods approved by the engineer will be allowed
- C. Shop Drawings: Indicate bar sizes, spacing, locations, and quantities of reinforcing steel and wire fabric, bending and cutting schedules, supporting and spacing devices, and beam reinforcing elevations
- D. Submit certified copies of mill test reports of reinforcement material analysis. Certify that products meet or exceed specified requirements

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Reinforcing Steel shall be free of heavy rust scales and flakes, or other coating at time of delivery and placing. Properly protect rebar on site after delivery to prevent rust scales and flaking

- B. Deliver bars separated by size and tagged with manufacturer's heat or test identification number

PART 2 - PRODUCTS**2.1 MATERIALS****A. Reinforcing Steel:**

1. For general use: Deformed, new billet steel bars conforming to ASTM A615. Provide Grade 60 bars (400 MPa) unless otherwise noted on Contract Drawings, bars shall have grade identification marks
2. For salt water pools, wet pits, and locations exposed to moisture: Deformed, new billet steel bars, conforming to ASTM A615, Grade 60 (400 MPa) bars, Epoxy Coated in accordance with ASTM D3963
3. For fresh water pools, wet pits, and locations exposed to moisture: Deformed, new billet steel bars conforming to ASTM A615, Grade 60 (400 MPa) bars. Provide Epoxy Coated bars where noted on Contract Drawings
4. Fabricate and bend reinforcing steel in accordance with latest edition of the "ACI Detailing Manual" and details on Contract Drawings

B. Welded Wire Fabric:

1. Welded Steel Wire Fabric with fiber yield strength of 60,000 psi (400 MPa) conforming to ASTM A185
2. Provide 4 x 4 – W1.4/1.4 (100 x 100 – MW9.1/9.1) for 4 inch (100mm) slabs and 6 x 6- W2.1/2.1 (150 x 150 – MW13.3/13.3) for 5 inch (125mm) slabs unless otherwise noted on the Contract Drawings
3. Provide mesh in flat sheets only. Mesh rolls will not be acceptable

C. Expanded Metal Lath:

1. Expanded Metal Lath with galvanized finish conforming to ASTM C847

D. Reinforcing Fibers:

1. Acceptable Manufacturers
 - a. Euclid Chemical, Fiberstrand 100
 - b. W. R. Grace, Grace Fibers
 - c. Fibermesh, Inc.
2. Fibrillated virgin polypropylene fibers, ¾ inch (20mm) long

E. Supports and Accessories

1. Tie Wire:
 - a. 14 gauge, 0.0641 inch (1.63mm) or 16 gauge, 0.0508 (1.29mm) deformed wire conforming to ASTM A496
 - b. 14 gauge, 0.0641 inch (1.63mm) or 16 gauge, 0.0508 (1.29mm) black, soft, smooth iron wire conforming to ASTM A82
2. Supports for Reinforcement:
 - a. Use 5,800 psi (40 MPa) pre-cast concrete chairs or "Dobies" with embedded wire ties where concrete is placed over water or vapor proof membranes
 - b. Wire bar type supports complying with CRSI MPS 1-90, Chapter 3, with spacers and upturned legs. Where support legs are in contact with forms, provide supports with plastic protected legs, CRSI Class C
 - c. Provide chairs, bar supports, spacers, or hangers as recommended by "ACI Detailing Manual", latest edition, except slab on grade. Engineer must approve work, materials, and methods.

PART 3 - EXECUTION**3.1 PLACEMENT**

- A. Provide following minimum concrete cover for reinforcement (ACI 318-89):
 - 1. Concrete cast against and permanently exposed to Earth
 - a. Exterior Slabs on Grade – 2 inches (50mm)
 - b. Interior Slabs on Grade – 2 inches (50mm)
 - c. Sections other than Slabs – 3 inches (75mm)
 - 2. Concrete exposed to Earth, Water, or Weather
 - a. No. 5 (T16) and smaller bars – 2 inches (50mm)
 - b. No. 6 (T19) and larger bars – 2 inches (50mm)
 - 3. Concrete not exposed to Earth, Water, or Weather
 - a. Slabs, Walls, and Joists – 1 inch (25mm)
 - b. Beams and Columns – 1.2 inches (37mm)
- B. Accurately place and support reinforcement with engineer approved chairs, bar supports, spacers, or hangers as recommended by the "ACI Detailing Manual", latest edition, except slabs on grade work. Support bars in slabs on grade and footings with specified and approved supports to maintain specified concrete cover.
- C. Securely anchor and tie reinforcing bars and dowels prior to placing concrete
- D. Coordinate with other trades, locations of all formed openings or penetrations for piping or conduits prior to placing concrete. Accommodate openings and penetrations by providing necessary reinforcement around openings
- E. Avoid splices of reinforcing bars at points of maximum stress. Lap bars 40 bar diameters minimum unless dimensioned otherwise on the Contract Drawings
- F. Run steel reinforcing bars continuous through cold joints
- G. Torches will not be allowed for cutting or bending reinforcing bars. Cut bars using cutter. Do not use torches to heat bars for bending, bend bars cold.
- H. Provide full length bars, accurately bent to details. Do not field bend bars partially embedded in concrete except as indicated on the Contract Drawings or specifically permitted by the engineer
- I. Bond and ground all reinforcement in accordance with National Electrical Code (NEC) requirements
- J. Lay welded wire fabric continuously, with edges and ends of adjoining sheets overlapping at least one full mesh, and not less than 6 inches (150mm), tie splices with 16 gauge, 0.0508 inch (1.29mm) wire. Offset end laps in adjacent sheets to prevent continuous laps
- K. Support welded wire fabric 2 feet (0.6m) on centers throughout the field and 2 feet (0.6m) on center along all edges

3.2 EXAMINATION

- A. Provide 48-hour notice to engineer to allow for inspection of completed concrete reinforcement before placing concrete
- B. Coordinate scheduling of concrete placement to allow for structural engineer inspection and observation and for making necessary adjustments to the reinforcing placement before delivery of concrete

END OF SECTION

SECTION 13 1203 – WATER FEATURE CONCRETE FORM WORK

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Formwork Materials
 - 2. Formwork Accessories
 - 3. Concrete Waterstops
- B. Related Sections:
 - 1. SECTION 13 1202 – WATER FEATURE STEEL REINFORCEMENT
 - 2. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 3. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 4. SECTION 13 1305 – WATER FEATURE ACCESSORIES
 - 5. SECTION 13 1401 – WATER FEATURE PVC AND HDPE PIPE AND FITTINGS
 - 6. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
 - 7. SECTION 13 1404 – WATER FEATURE WHITE GOODS
- C. References:
 - 1. ACI 117 – SPECIFICATIONS FOR TOLERANCES FOR CONCRETE CONSTRUCTION AND MATERIALS
 - 2. ACI 301 – SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS
 - 3. ACI 318 – BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE
 - 4. ACI 347 – GUIDE TO FORMWORK FOR CONCRETE
 - 5. PS 1 – CONSTRUCTION AND INDUSTRIAL PLYWOOD

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's product data, materials, specifications, installation recommendations, and maintenance data for Waterstops and expansion joint material
- C. Shop Drawings: Provide engineered and stamped shop drawings for shoring and bracing, including details, member sizes, and sequencing instructions, when required

1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 347, 318, and the latest edition of the Building Code adopted by the governing agency
- B. Design Formwork under direct supervision of a Licensed Professional Engineer experienced in design of this Work
- C. Safety: Assume responsibility for safety of Formwork and provide necessary design construction, materials, and maintenance to produce required concrete work safely
- D. All work to be performed in accordance with local Building Code Regulations and OSHA guidelines

PART 2 - PRODUCTS**2.1 FORMWORK MATERIALS**

- A. Conform to ACI 347, Chapter 4 – Materials for Formwork, ACI Special Publication No. 4 – Formwork for Concrete, and as herein specified
- B. Lumber
 - 1. Softwood Framing Lumber: In accordance with AFPA – National Design Specification for Wood Construction, with Supplement. Provide Lumber with a moisture content of 19 percent or less

2. Grade marked by grading rules agency listed in National Design Specification for Wood Construction
 3. Light framing or studs for board or plywood form: 2 inch to 4 inch (50 to 100mm) and larger in nominal width and thickness. Construction Grade
 4. Boards for basic forms and form liners: Construction Grade
 5. Board Pattern: Square Edge
 6. Board Surface: Surfaced Four Sides (S4S)
- C. Plywood:
1. For exposed concrete surfaces: HD Overlay Plyform, B-B Grade, Class I or II (exterior) APA stamped, 5/8 inch (16mm) thick minimum
 2. All other locations: Plyform, B-B Grade, Class I or II (exterior) APA stamped, 5/8 inch (16mm) thick minimum
 3. Furnish in largest practicable sizes to minimize the number of joints
- D. Round Column Forms: S
1. Single-use Fiber/Tubes with separate plastic liner, "Spiral Stop" as manufactured by Greenstreak
 2. Single-use Fiber/Tubes with integral plastic liner, "Smooth Tube" as manufactured by Burke
- E. Fiberglass, plastic, and metal forms:
1. May be used, subject to approval by Engineer, if they produce concrete surfaces equivalent to those resulting from the use of plywood forms, in the judgment of the Engineer
- F. Chamfer Strips:
1. 3/4 inch (19mm) Type VE-2 PVC Strips by Vulcan Metal Products, Inc.
 2. Approved equal
- G. Wire Mesh Pool Forms:
1. Steeltex Wire Mesh with waterproof backing and tri-direction fiberglass reinforcing fibers as manufactured by Ivy Steel & Wire
 2. Approved equal
- H. Pool Gutter Forms:
1. High Density Styrofoam with Polyurethane Coating, custom cut to the pool design geometry as manufactured by Lawson Aquatics
- 2.2 FORMWORK ACCESSORIES
- A. Form Ties:
1. Removable or Snap-off type, galvanized metal, fixed length, cone type, with waterproofing washer, and free of defects
 2. Form Release Agent:
 - a. Approved Manufacturers
 - i. Crete-Lease 727 or 20-VOC by Cresset Chemical Company
 - ii. CleanStrip (J-1 or J-3 VOC) by Dayton Superior
 - iii. DEBOND Form Coating by L&M Construction Chemicals
 - iv. Duogard or Duogard II by W. R. Meadows
 - v. Approved equal that will provide CCS-2 surface minimum as approved by Engineer
 - b. Non-staining clear coating that does not contain oil or wax and will not prevent proper adhesion of applied finish
 - c. Release Agents shall be compatible with forming materials

3. Pressure Sensitive Tape:
 - a. Approved Manufacturers
 - i. 3M
 - ii. Approved Equal
 - b. Polyurethane or Mylar faced adhesive backed paper tape, 1 inch (25mm) wide, used for all Formwork joints
4. Nails, Spikes, Lag Bolts, Through Bolts, Anchors:
 - a. Sized as required, of sufficient strength and character to maintain Formwork in place while placing concrete

2.3 CONCRETE WATERSTOPS

A. Rubber Waterstops:

1. Approved Manufacturers
 - a. Sika Greenstreak
 - b. Williams Everlastic Waterstop System
 - c. BF Goodrich Industrial Products, BFG Vinyl Waterstops
 - d. W. R. Meadows, Incorporated, Sealtight
 - e. Earth Shield TPE
2. Extruded ribbed or dumbbell type, 6 inch (150mm) minimum length, tensile strength equal to concrete design strength
3. Splice by means of thermal butt fusion
4. Center bulb styles shall not be used, unless specifically approved by the Engineer

B. Bentonite/Butyl Rubber Waterstops:

1. Acceptable Manufacturers:
 - a. Waterstops RX
 - b. Sika Sikaswell 2
 - c. Parastop II
2. Waterstop shall be 75 percent Bentonite and 25 percent butyl rubber blended together to form a rope material having sectional dimension of 1 inch (25mm) by $\frac{3}{4}$ inch (19mm)
3. Bentonite/Butyl Rubber Waterstops shall only be approved for use in conjunction with existing concrete and new concrete joints

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and centers before proceeding with Formwork. Ensure all dimensions agree with Contract Documents, notify the Engineer of any discrepancies

3.2 ERECTION – FORMWORK

- A. Earth forms are only permitted where pre-approved by the Engineer or Architect
- B. Erect formwork, shoring, and bracing to achieve design requirements in accordance with ACI 301
- C. Provide bracing to ensure stability of Formwork. Shore to strengthen Formwork subject to overstressing by construction loads
- D. Arrange and assemble Formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores

- E. Arrange Formwork, aligning joints, lock forms in place making joints water tight. Tape inside of joints. Keep form joints to a minimum
- F. Provide ¼ inch (19mm) tooled edges or chamfer strips on external corners of all exposed concrete, except where noted on Contract Documents. Outside corners of all pool edges shall have a minimum 2 inch (50mm) tooled edge
- G. Maintain required clear cover between reinforcing bars and Formwork

3.3 APPLICATION – FORM RELEASE AGENT

- A. Apply Form Release Agent on Formwork in accordance with the Manufacturer's recommendations
- B. Apply Form Release Agent prior to placement of reinforcing steel, anchoring devices, and embedded items
- C. Do not apply Form Release Agent where concrete surfaces will receive special finishes or applied coverings that are affected by Form Release Agents. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete
- D. Do not allow Form Release Agent on reinforcing steel or concrete surfaces where bonding is intended to occur or at locations of cold joints

3.4 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items embedded in or passing through concrete Work
- B. Locate and set in place items that will be cast directly into concrete. Coordinate with all other trades to insure all items to be embedded into concrete are installed and set prior to placing concrete
- C. Locate and coordinate all pipe penetrations as shown on the Contract Documents. Notify Structural Engineer of any penetrations not shown on the Contract Documents where the structural members are shown, obtain approval from the Engineer prior to placing concrete. Install any additional reinforcement as directed by the Structural Engineer
- D. Install Waterstop Flanges for all water feature pipe penetrations into water holding structures and Link Seals for penetrations into non-water holding structures.
- E. Coordinate with other trades in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other trades
- F. Install accessories in accordance with the Manufacturer's instructions. Accessories shall be straight, level, and plumb. Ensure items are not disturbed during concrete placement
- G. Install Concrete Waterstops in accordance with the Manufacturer's instructions continuous without displacing reinforcement. Joints shall be water tight
- H. Bentonite/Butyl Rubber Waterstops shall be applied at all below grade construction joints a minimum of 2 inches (50mm) from the exterior face of concrete. To prevent movement, attach water stop to the concrete with harden nails every 12 to 18 inches (300 to 450mm) or use approved epoxy continuous along Waterstop. Prevent damage to Waterstop while placing concrete
- I. Provide temporary ports or openings in Formwork where required to facilitate cleaning and inspection. Located openings at bottom of forms to allow flushing water to drain
- J. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces

3.5 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms
- B. Clean formed cavities of debris prior to placing concrete

- C. Flush with water or use compressed air to remove foreign matter. Ensure that water and debris drain to exterior through temporary openings or clean-out ports

3.6 FORMWORK TOLERANCES

- A. Construct Formwork to maintain tolerances required by ACI 301
- B. Camber slabs and beams in accordance with ACI 301

3.7 FIELD QUALITY CONTROL

- A. Inspect erected Formwork, shoring, and bracing to ensure that Work is in accordance with Formwork design, and that supports, fastenings, wedges, ties, and items are secure
- B. Do not reuse plywood Formwork more than three (3) times for concrete surfaces to be exposed to view or Formwork that has become split, frayed, delaminated, or otherwise damaged. Do not patch Formwork

3.8 FORM REMOVAL

- A. Do Not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads
- B. Loose forms carefully. Do not wedge pry bars, hammers, or tools against finished concrete surfaces schedule for exposure to view
- C. Store removed forms in a manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms

END OF SECTION

SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Concrete Materials
 - 2. Admixtures
 - 3. Miscellaneous Materials
 - 4. Concrete Mixes
 - 5. Cementitious and Reactive Waterproofing
- B. Related Sections:
 - 1. SECTION 03 0000 - CONCRETE
 - 2. SECTION 13 1201 – WATER FEATURE LIGHTWEIGHT STRUCTURAL FILL
 - 3. SECTION 13 1202 – WATER FEATURE STEEL REINFORCEMENT
 - 4. SECTION 13 1203 – WATER FEATURE CONCRETE FORMWORK
 - 5. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 6. SECTION 13 1305 – WATER FEATURE ACCESSORIES
 - 7. SECTION 13 1401 – WATER FEATURE PVC AND HDPE PIPE AND FITTINGS
 - 8. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
 - 9. SECTION 13 1404 – WATER FEATURE WHITE GOODS
 - 10. SECTION 31 0000 – EARTHWORK
- C. References:
 - 1. Project Documents: Geotechnical Soils Report
 - 2. ACI 107 – SPECIFICATION FOR TOLERANCES FOR CONCRETE CONSTRUCTION AND MATERIALS
 - 3. ACI 211.5R – GUIDE FOR SUBMITTAL OF CONCRETE PROPORTIONS
 - 4. ACI 301 – SPECIFICATION FOR STRUCTURAL CONCRETE FOR BUILDINGS
 - 5. ACI 302.1R – GUIDE FOR CONCRETE FLOOR AND SLAB CONSTRUCTION
 - 6. ACI 303.1 – STANDARD SPECIFICATION FOR CAST-IN-PLACE ARCHITECTURAL CONCRETE
 - 7. ACI 304 – MEASURING, MIXING, TRANSPORTING, AND PLACING CONCRETE
 - 8. ACI 305R – SPECIFICATION FOR HOT WEATHER CONCRETING
 - 9. ACI 306.1 – STANDARD SPECIFICATION FOR COLD WEATHER CONCRETING
 - 10. ACI 308.1 – STANDARD SPECIFICATION FOR CURING CONCRETE
 - 11. ACI 318 – BUILDING CODE REQUIREMENTS
 - 12. ACI 350 – CODE REQUIREMENTS OF ENVIRONMENTAL ENGINEERING CONCRETE STRUCTURES
 - 13. ACI 503.2 – BONDING PLASTIC CONCRETE TO HARDENED CONCRETE WITH A MULTI-COMPONENT EPOXY ADHESIVE
 - 14. ASTM C33 – STANDARD SPECIFICATION FOR CONCRETE AGGREGATES
 - 15. ASTM C88 – STANDARD TEST METHOD FOR SOUNDNESS OF AGGREGATES BY USE OF SODIUM SULFATE OR MAGNESIUM SULFATE
 - 16. ASTM C94/C94M – STANDARD SPECIFICATION FOR READY-MIX CONCRETE
 - 17. ASTM C150 – STANDARD SPECIFICATION FOR PORTLAND CEMENT
 - 18. ASTM C260 – STANDARD SPECIFICATION FOR AIR-ENTRAINING ADMIXTURES FOR CONCRETE
 - 19. ASTM C277 – SPECIFICATION FOR MAGNESIUM SULFATE
 - 20. ASTM C289 – STANDARD TEST METHOD FOR POTENTIAL ALKALI-SILICA REACTIVITY OF AGGREGATES (CHEMICAL METHOD)
 - 21. ASTM C309 – STANDARD SPECIFICATION FOR LIQUID MEMBRANE-FORMING COMPOUNDS FOR CURING CONCRETE
 - 22. ASTM C494 – STANDARD SPECIFICATION FOR CHEMICAL ADMIXTURES FOR CONCRETE
 - 23. ASTM C618 – STANDARD SPECIFICATION FOR COAL FLY ASH AND RAW OR CALCINED NATURAL POZZOLAN FOR USE IN CONCRETE

24. ASTM C948 – STANDARD TEST METHOD FOR DRY AND WET BULK DENSITY WATER ABSORPTION AND APPARENT POROSITY OF THIN SECTIONS OF GLASS-FIBER REINFORCED CONCRETE

D. Related Products Installed But Not Supplied Under This Section:

1. Inserts, bolts, boxes, templates, and fastening devices for other Work, Including those for bases for Mechanical and Electrical
2. Concrete Accessories

1.2 SUBMITTALS FOR REVIEW

A. SECTION 01 3300 – SUBMITTAL PROCEDURES

- B. Product Data: Submit Manufacturer's product literature for each type of admixture, bonding agent, curing compound, non-shrink grout, epoxy, and sealer for approval by the Engineer

- C. Concrete Mix Design: Submit Concrete Mix Design for each concrete mix type to be used. Include the following information:

1. Mix Identification Designation
2. Statement of Intended Use for Mix
3. Mix Proportions, including Admixtures
4. Wet and Dry Unit Weight
5. Entrained Air Content
6. Design Slump
7. Design Compressive Strength
8. Water/Cementitious Material Ratio
9. Aggregate Source
10. Admixtures
11. Strength Qualification Data:
 - a. Submit required average strength qualification data and documentation per ACI 301 4.2.3
 - b. If trial batches are used to qualify average strength, mix design shall be prepared by an independent testing laboratory and shall achieve average compressive strength a minimum of 1,200 psi (8.25 MPa) greater than specified strength with slump within 1 inch (25mm) of maximum permitted and air content within 0.05% of maximum allowable
 - c. If field test data is used to qualify average strength, submit separate qualification data for each production facility that will supply concrete to the project, include copies of concrete testing agency's reports from which the data was compiled

- D. Test Reports: Provide Test Reports of control tests, special tests, and core tests prepared and distributed by an independent testing laboratory

- E. Samples: Submit one (1) 12 inch by 12 inch (300 by 300mm) sample of colored concrete for color verification

1.3 QUALITY ASSURANCE

- A. Testing Agency: All testing shall be conducted by an approved testing laboratory. Test results will be submitted to the Engineer before final acceptance

- B. Records of Work: Maintain and keep accurate records listing time, location, and date of concrete placement. Include delivery tickets from concrete supplier. Delivery Tickets shall show the following information:

1. Name of Ready-Mix batch plant
2. Serial number of Ticket
3. Date and truck number
4. Name of Contractor
5. Name and Location of the Project

6. Amount of Concrete
7. Time Loaded
8. Type, Name, and Amount of Admixtures used
9. Amount and Type of Cement
10. Total Water Content
11. Sizes, Weights, and Types of sand and aggregates

C. MOCKUP

1. Construct and erected a field sample for Architectural Concrete surfaces receiving special treatment or finish as a result of Formwork in location specified by the Engineer or Architect.
2. Sample shall be of sufficient size, approximately 4 feet by 8 feet (1.2 by 2.4m), to indicated and detail special treatment or finish, including any scoring, joints, joint sealants, etc that will be in the finished Work
3. Remove panels at the completion of the Project

1.4 PROJECT CONDITIONS

A. Environmental Requirements

1. Cold Weather Concreting Procedures
 - a. When ambient air temperatures on the day of placement are expected to drop below 40 °F (4.4 °C), placement, preparation, protection, and curing of concrete shall comply with ACI 306.1
 - b. Minimum temperature of concrete upon delivery shall conform to ACI 301 4.2.2.7. Concrete temperature at placement shall conform to minimum values of ACI 306.1 Table 3.2.1, and shall not exceed minimum values
 - c. No frozen material shall be used
 - d. Forms, reinforcement, and fillers shall be free from frost
 - e. Do not place concrete on frozen ground
2. Hot Weather Concreting Procedures
 - a. When placing concrete in hot weather follow the recommendations of ACI 305R
 - b. When ambient air temperatures on the day of placement are expected to exceed 90 °F (32.2 °C), mix ingredients shall be cooled before mixing. Flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of mix water
 - c. Protect and prevent rapid drying. Start finishing and curing as soon as possible. The Engineer may approve the use of fog spray or evaporation retardant to lessen rapid evaporation from concrete surface
3. Concrete shall not be placed during rain, sleet, or snow. Precipitation shall not be allowed to increase the mixing water nor damage the finish surface. The Engineer may approve placement of concrete if it is determined that there is adequate protection from damage due to environmental conditions

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement:

1. General Usage: ASTM C150, Type II with C3A ≤ 5% or Type V, provided from one (1) source

B. Coarse Aggregate:

1. Meet requirements of ASTM C33 or nonconforming aggregate that by test or actual service produces concrete of required strength and conforms to local governing codes
2. Aggregate shall be uniformly graded as follows:

a. Flat Work – Size No. 67

Sieve No. (U.S. Series)	Opening Size inches (mm)	Percent Retained (% by weight)
1 in.	1.0 (25)	100
3/4 in.	0.75 (19)	90 to 100
3/8 in.	0.375 (9)	20 to 55
4	0.187 (4.75)	0 to 10
8	0.0937 (2.36)	0 to 5

b. All Other – Size No. 57

Sieve No. (U.S. Series)	Opening Size inches (mm)	Percent Retained (% by weight)
1-1/2 in.	1.5 (37)	100
1 in.	1.0 (25)	95 to 100
1/2 in.	0.5 (12)	25 to 60
4	0.187 (4.75)	0 to 10
8	0.0937 (2.36)	0 to 5

C. Fine Aggregates:

- Clean, washed hardrock having hard, strong, durable particles, which do not contain deleterious substances, such as clay lumps, shale, schist, alkali, mica, coated grains, or soft and flaky particles
- Clean natural sand, which does not contain deleterious substances, such as clay lumps, shale, schist, alkali, mica, coated grains, or soft and flaky particles
- Aggregate shall be uniformly graded as follows:

Sieve No. (U.S. Series)	Opening Size inches (mm)	Percent Retained (% by weight)
3/8 in.	0.375 (9)	100
4	0.187 (4.75)	95 to 100
8	0.0937 (2.36)	80 to 100
16	0.0469 (1.18)	50 to 85
30	0.0234 (0.60)	25 to 60
50	0.0117 (0.30)	10 to 30
100	0.0059 (0.15)	2 to 10

D. Mix Water:

- Clean potable water conforming to ASTM C94
- Free from deleterious amounts of acids, alkalis, salts, and organic matter

2.2 ADMIXTURES

A. Mineral

- Fly Ash Pozzolan – Meets requirements of ASTM C618, Class F or C and with loss of ignition (LOI) of 3 percent maximum

B. Chemical

- No Admixture shall contain calcium chloride nor shall calcium chloride be used as an Admixture. All chemical admixtures used shall be from the same manufacturer
- Approved Manufacturer
 - Master Builders Incorporated
 - SIKA Corporation

-
- c. W R Grace Construction Products
 - 3. Air Entrainment Agent
 - a. Meets requirements of ASTM C260
 - b. Quality Standard – Daravair or Darex II AEA by W R Grace
 - 4. Water Reducer
 - a. Meets requirements of ASTM C494, Type A
 - b. Quality Standard – Daracem 50/55, WRDA-64, or WRDA-82 by W R Grace
 - 5. Water Reducer, Set Retarder
 - a. Meets requirements of ASTM C494, Type D
 - b. Quality Standard – Daratard-17 or Daratart-40 by W R Grace
 - 6. High Range Water Reducer
 - a. Meets requirements of ASTM C494, Type F or G
 - b. Quality Standard – Darachem-100 or WRDA-19 By W R Grace
 - 7. Non-Chloride Accelerator
 - a. Meets requirements of ASTM C494, Type C
 - b. Quality Standard – Daraset or Polarset by W R Grace
 - C. Evaporation Retardant
 - 1. Approved Manufacturers
 - a. Sure Film J-74 by Dayton Superior
 - b. Confilm by Master Builders Incorporated
 - D. Bonding Agents
 - 1. Approved Manufacturers
 - a. Day-Chem Ad Bond (J-40) by Dayton Superior
 - 2.3 MISCELLANEOUS MATERIALS
 - A. Curing Compounds:
 - 1. Do not use concrete curing compounds without the Engineer's or Architect's written approval
 - 2. Curing Compounds shall not be used to replace moist curing unless specifically accepted by the Engineer
 - B. Non-shrink Grout:
 - 1. Approved Manufacturers
 - a. Master Builders Incorporated – Master Flow 928
 - b. Dayton Superior – Sure-Grip
 - c. L&M Construction Chemicals – Crystex Non-Shrink Grout
 - d. Euclide Chemical Company – Hi-Flow Grout
 - e. U.S. Grout Corporation – Five Star Grout
 - f. A.C. Horn, Incorporated – Horn Non-Metallic Grout
 - g. UPCO Company – UPCON
 - h. Sonneborn Building Products – Sonogrout
 - i. Burke – Non-Ferrous, Non-Shrink Grout
 - 2. Pre-packaged, non-shrink, non-metallic, natural aggregate grout conforming to ASTM C1107, Grade B or C

3. Grout shall be fluid with extended working times and temperatures, capable of achieving at least 95 percent bearing strength under base plates and free of gas producing or gas-releasing agents
- C. Anchor Bolt Epoxy
 1. Approved Manufacturers
 - a. Hilti Corporation
 - b. Approved Equal
 2. Anchor Bolt Epoxy shall conform to the design strength requirements of ACI 318 and should follow the Manufacturer's recommendations
 3. Provide as an injectable adhesive, furnished in a side-by-side refill pack that keeps component A and component B separate and shall be designed to accept static mixing nozzle through which both components are thoroughly mixed.
- D. Expansion Joint Filler
 1. Wet Areas, such as pool decks:
 - a. Acceptable Products
 - i. Deck-O-Joint
 - ii. Deck-O-Foam
 - iii. Deck-O-Seal
 - iv. Approved Equal
 - b. Non-bituminous joint filler, ½ inch (12mm) thick by depth of concrete slab
 2. Non-Wet Areas:
 - a. Acceptable Manufacturers
 - i. A.C. Horn Company
 - ii. W R Meadows Company
 - iii. Approved Equal
 - b. Pre-molded asphalt-impregnated type, conforming to ASTM D1751
 - c. Pre-compressed, neoprene rubber-impregnated, expanding foam may be used in lieu of pre-molded type

2.4 CONCRETE MIXES

- A. It is intended that concrete for all parts of the concrete Work be homogeneous, and when harden, possess the required strength, durability, water tightness, appearance, resistance to deterioration and abrasion, and other qualities as specified or required
- B. No water shall be added at anytime during mixing cycle above the amount required to meet specified water/cement ratio. No reduction in the amount of cement will be allowed
- C. Mix Designs to meet the following requirements:
 1. Mix No. 1 – 5,000 psi (34.4 MPa) concrete for use on water retaining structures
 - a. Minimum weight of cement per cubic yard – 564 lbs
 - b. Air Entrainment – 6 percent, +/- 1.5%
 - c. Water/Cement Ratio – 0.40 maximum by weight
 2. Admixtures:
 - a. Mix design shall show proposed admixture, amount, usage instructions, and justification for proposed use. Do not use any admixture without the Engineer's/Architect's written approval

- b. Mineral – An amount equal to 15 percent of weight of cement may be added.
 - i. If added, fly ash shall be considered with the cement in determining the amount of water necessary to provide the specified water/cement ratio
- c. Chemical:
 - i. 4 inch (100mm) slump maximum prior to use of high range water reducer
 - ii. 8 inch (200mm) slump maximum with use of high range water reducer
 - iii. Use accelerator or retarder if necessary to meet environmental conditions

2.5 CEMENTITIOUS AND REACTIVE WATERPROOFING

- A. Cementitious and Reactive Waterproofing should only be included in the mix design when specified by the Engineer
- B. Cementitious Waterproofing
 - 1. Approved Manufacturers
 - a. XYPEX Chemical Corporation
 - b. Approved Equal
 - 2. Obtain crystalline waterproofing products from a single manufacturer
 - 3. Product shall be added to concrete mix at time of batching
 - 4. Follow all Manufacturer recommendations and instructions for dose rates into concrete mix
- C. Reactive Waterproofing
 - 1. Approved Manufacturers
 - a. HYCRETE Incorporated
 - b. Approved Equal
 - 2. Obtain Reactive Waterproofing products from a single manufacturer
 - 3. Product shall be compatible with specified concrete mix design
 - 4. Follow all Manufacturer's recommendations and instructions for dose rates into the concrete mix

PART 3 - EXECUTION

3.1 PREPARATION

- A. Refer to overall Project Specifications for inspection requirements
- B. Verify requirements for concrete cover over reinforcement in accordance with SECTION 13 1202 – WATER FEATURE STEEL REINFORCEMENT
- C. Coordinate locations and install inserts, bolts, boxes, templates, pipes, conduits, and other accessories required by all other trades prior to inspection and placing concrete
- D. Verify area where concrete is to be placed is free from standing water, dirt, debris, and etc
- E. Clean previously placed concrete with a steel brush, blowing the concrete clean using compressed air, and wetting or applying bonding agent in accordance with Manufacturer's instructions
- F. Verify that all grounding connections are installed prior to placing concrete. All Steel Reinforcement must be grounded in accordance with the National Electrical Code (NFPA 70)

3.2 PLACEMENT

- A. Place concrete in accordance with ACI 318
- B. Place concrete on properly prepared undisturbed subgrade materials or engineered fill. Refer to the Geotechnical Soils Report for recommendations

- C. Maintain records of concrete placement as described in this section
- D. Place concrete continuously between predetermined expansion, control, and construction joints
- E. Do not interrupt successive placement; do not permit cold joints to occur
- F. Place concrete in nearly uniform layers.
- G. Do not drop concrete in free fall over 5 feet (1.5m)
- H. Consolidate concrete during and immediately after depositing using mechanical vibrators in accordance with ACI 301. Do not use vibrators to move or transport concrete inside of forms
- I. Do not use contaminated, deteriorated, or retempered concrete. Avoid accumulation of hardened concrete
- J. Do not use aluminum in concrete

3.3 ACCEPTABLE TOLERANCES

- A. All tolerances for concrete work shall be in accordance with ACI Standards unless specifically specified otherwise
- B. Tolerances for blockouts and openings:
 - 1. Size: $\pm 1/8$ inch (3mm)
 - 2. Location: $\pm 1/4$ inch (6mm)
- C. Tolerances for stairs and landings:
 - 1. Treads: $\pm 1/8$ inch (3mm)
 - 2. Risers: $\pm 1/16$ inch (1.5mm)
- D. Walls and Slabs:
 - 1. Variation from plumb: $1/4$ inch (6mm) maximum
 - 2. Variation from thickness: $1/4$ inch (6mm)
 - 3. Variation from location: $1/2$ inch (12mm)

3.4 SPECIAL REQUIREMENTS

- A. Footings:
 - 1. Bear 18 inch (450mm) minimum into undisturbed earth or on mechanically compacted engineered fill. Step Footings at a ratio of 1.5 horizontal to 1 vertical (1.5:1) unless detailed otherwise. Exterior Footings shall bear below finish grades. See Contract Documents
 - 2. Level tops to finish Footing and leave rough
 - 3. Where joints are required, bulkhead, waterstop, key horizontally, and dowel with two (2) #4 (T12) rebar, 4 feet (1.2m) long
- B. Foundations and Walls:
 - 1. Leave Steel Reinforcement projecting where required for floor ties
- C. Exterior Slabs
 - 1. Dusting with cement is not permitted
 - 2. For continuous placing and where shown on the Contract Documents, saw cut a 1 inch (25mm) deep control joint before shrinkage occurs
- D. Equipment Support Pads (Housekeeping Pads)
 - 1. Coordinate the location of required equipment bases, support pads, etc with other trades and as required in all specification sections

2. All equipment support pads shall be 4 inches (100mm) in height, unless otherwise noted on the Contract Documents
 - E. Anchor Bolts:
 1. Embedded Anchors:
 - a. Place Anchor Bolts not tied to reinforcement steel immediately following leveling of concrete. Reconsolidate concrete around Bolt immediately after placement. Do not bolts during finishing process
 2. Epoxy Anchors:
 - a. Install as per the Manufacturer's recommendations and instructions
 - F. Expansion Joints:
 1. Install Expansion Joints only in locations where shown on the Contract Documents, or where approved by the Engineer
 2. Expansion Joint fiber can be held in place by nailing or taping the material to the existing section of concrete prior to placement
 3. Joint sealant compound shall be applied over the top of the fiber, flush with the finish surface and continuous along the entire joint. The joint shall be water tight
- 3.5 CONCRETE FINISHES
- A. All Concrete Finishes shall be coordinated with the Architect/Landscape Architect. The following are recommendations when no architectural finish is specified
 - B. Finish No. 1 – Exposed Vertical Surfaces
 1. Sack Rubbed Finish
 2. Immediately after removing forms, remove joints, marks bellies, projections, loose materials, and cut back metal ties from surfaces to be exposed
 3. Repair minor voids as specified in this section, and rub exposed surface with carborundum to smooth
 4. Grind ridges smooth with the face of the exposed concrete
 5. Provide a smooth and even surface
 - C. Finish No. 2 – Interior Flatwork
 1. Steel Trowel Finish
 2. Float and Steel Trowel interior slabs after concrete has set enough to avoid bringing water and fines to the surface
 3. If power troweling is used, obtain approval or finish from the Engineer
 - D. Finish No. 3 – Exterior Flatwork
 1. Broom Finish
 2. Round edges including edges formed by expansion joints
 3. Remove edge marks
- 3.6 CURING AND PROTECTION
- A. Keep concrete moist a minimum of seven (7) days for regular concrete and three (3) days for high early strength concrete. Do not use concrete curing compounds without the Engineer/Architect's written approval. Curing Compounds shall not be used to replace moist curing unless accepted by the Engineer/Architect
 - B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury

- C. Maintain concrete with minimal moisture loss at relatively constant temperature for a period necessary to hydration of cement and hardening of concrete
- D. Protect newly placed concrete from precipitation until it has sufficiently hardened to avoid excess water in mix and damaging the surface finish. Concrete with damaged surfaces will be replaced at the direction of the Engineer

3.7 FIELD QUALITY CONTROL

- A. Provide a free access to Work and cooperated with individuals performing tests, inspectors, Engineers and Architects
- B. Four (4) concrete cylinders shall be taken for every 75 or less cubic yards (60 cu. m) of each class of concrete placed
- C. One (1) additional test cylinder will be taken during cold weather concreting and cured on the job site under the same conditions as concrete it represents
- D. One slump test will be taken for each set of test cylinders taken
- E. Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements will be noted as defective. Defective concrete will be removed and replaced, or repaired as directed by the Engineer and at the Contractor's expense

3.8 PATCHING AND REPAIRING

- A. Allow Engineer/Architect or inspector to inspect concrete surfaces immediately upon removal of forms
- B. Excessive honeycomb or embedded debris in concrete is not acceptable and will be noted as defective. Defective concrete will be removed and replaced, or repaired as directed by the Engineer and at the Contractor's expense
- C. Do not patch, repair or replace exposed architectural finished concrete except upon the direction of the Architect or Engineer
- D. Minor defects, defects less than 1/2 inch (12mm) deep and tie holes, not exposing reinforcing can be repaired by chipping, cleaning and applying epoxy adhesive. Apply non-shrink grout prior to development of tack-free condition of epoxy adhesive

END OF SECTION

SECTION 13 1205 – WATER FEATURE SHOTCRETE

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Shotcrete Materials
 - 2. Admixtures
 - 3. Miscellaneous Materials
 - 4. Proportioning and Design of Mixes
 - 5. Water Feature Shotcrete Equipment
- B. Related Sections:
 - 1. SECTION 03 0000 - CONCRETE
 - 2. SECTION 13 1201 – WATER FEATURE LIGHTWEIGHT STRUCTURAL FILL
 - 3. SECTION 13 1202 – WATER FEATURE STEEL REINFORCEMENT
 - 4. SECTION 13 1203 – WATER FEATURE CONCRETE FORMWORK
 - 5. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 6. SECTION 13 1301 – WATER FEATURE PLASTER FINISHES
 - 7. SECTION 13 1302 – WATER FEATURES TILE FINISHES
 - 8. SECTION 13 1305 – WATER FEATURE ACCESSORIES
 - 9. SECTION 13 1401 – WATER FEATURE PVC AND HDPE PIPE AND FITTINGS
 - 10. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
 - 11. SECTION 13 1404 – WATER FEATURE WHITE GOODS
 - 12. SECTION 31 0000 – EARTHWORK
- C. References:
 - 1. Project Document: Geotechnical Soils Report
 - 2. ACI 506.2 – SPECIFICATION FOR SHOTCRETE
 - 3. ASTM C33 – STANDARD SPECIFICATION FOR CONCRETE AGGREGATES
 - 4. ASTM C94 – STANDARD SPECIFICATION FOR READY-MIX CONCRETE
 - 5. ASTM C150 – STANDARD SPECIFICATION FOR PORTLAND CEMENT
 - 6. ASTM C260 – STANDARD SPECIFICATION FOR AIR-ENTRAINING ADMIXTURES FOR CONCRETE
 - 7. ASTM C330 – STANDARD SPECIFICATION FOR LIGHTWEIGHT AGGREGATES FOR STRUCTURAL CONCRETE
 - 8. ASTM C494 – STANDARD SPECIFICATION FOR CHEMICAL ADMIXTURES FOR CONCRETE
 - 9. ASTM C685 – STANDARD SPECIFICATION FOR CONCRETE MADE BY VOLUMETRIC BATCHING AND CONTINUOUS MIXING

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's product literature for each type of admixture, patching compound, supports, backing materials, etc used in or on the shotcrete material
- C. Concrete Mix Design: Submit Shotcrete Mix Design for each shotcrete mix type to be used. Include the following information:
 - 1. Mix Identification Designation
 - 2. Statement of Intended Use for Mix
 - 3. Mix Proportions, including Admixtures
 - 4. Wet and Dry Unit Weight
 - 5. Entrained Air Content
 - 6. Design Slump

7. Design Compressive Strength
 8. Water/Cementitious Material Ratio
 9. Aggregate Source
 10. Admixtures
 11. Strength Qualification Data:
 - a. Submit required average strength qualification data and documentation per ACI 301 4.2.3
 - b. If trial batches are used to qualify average strength, mix design shall be prepared by an independent testing laboratory and shall achieve average compressive strength a minimum of 1,200 psi (8.25 MPa) greater than specified strength with slump within 1 inch (25mm) of maximum permitted and air content within 0.05% of maximum allowable
 - c. If field test data is used to qualify average strength, submit separate qualification data for each production facility that will supply concrete to the project, include copies of concrete testing agency's reports from which the data was compiled
 - D. Test Reports: Provide Test Reports of control tests, special tests, and core tests prepared and distributed by an independent testing laboratory
 - E. Shop Drawings: For Artificial Rockwork applications, provide shop drawings showing the following information:
 1. Indicate formwork, shaped earthwork, dimensions and thickness, tolerances, contours, reinforcement, accessories, and structural steel for secondary support
- 1.3 QUALIFICATIONS
- A. Installer Experience: Company specializing in performing the work of this section with minimum of five (5) years experience and approved by the Engineer/Architect
 - B. Nozzlemen shall have current certification in accordance with ACI 506.3R for type of shotcrete required
- 1.4 TEST PANELS AND MOCKUPS
- A. Test Panels shall be prepared by each nozzleman and tested for all applications of shotcrete per the following requirements:
 1. Make three (3) test panels at least 30 by 30 inches (750 by 750mm) for each mix being considered and each surface and shooting positions encountered on the Project
 - a. For example: panels representing vertical walls shall be shot with the panels in a vertical position. Panels representing horizontal surfaces shall be shot with the panels in a horizontal position
 - b. Comply with applicable provisions of ASTM C1140
 - c. Fabricate test panels to the same thickness as the structure to be shot, but not less than 6 inches (150mm)
 2. Provide the same reinforcement in the test panel as used in the structure, placed in at least half the panel to check for proper shotcrete placement around reinforcing steel. Panels may be cut to visually inspect proper placement
 3. Each application crew performing shotcrete Work shall be required to make test panels
 4. Take one (1) 3 inch (75mm) diameter core specimens from each panel for testing. Test specimens for strength in accordance with ASTM C42. The average compressive strength of the cores taken from the test panels must equal or exceed 85 percent of specified compressive strength
 - B. Mock-up for applications for Special Architectural Treatment:
 1. Construct and erect a field sample for each type of shotcrete structure receiving a special architectural treatment or finish
 2. Sample panel sized sufficiently, typically 4 feet (1.2m) high by 8 feet (2.4m) in length, to indicated all aspects of the special treatment or finish

3. Provide same method of construction and reinforcement in mock-ups as used in the structure. Apply finish treatment to mock-up
4. Modify final finished treatment, or construct additional mock-ups, as required until acceptable to the Architect/Landscape Architect. Accepted sample panel is considered basis of quality for the finished Work
5. Locate panels where directed by the Architect/Engineer. Mock-up may not remain as part of the Work and must be removed at the end of the Project

1.5 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. ACI 301 and 506.2
 2. Concrete Reinforcing Steel Institute (CRSI) – Manual for Standard Practice
- B. Testing Service: Engage an independent testing laboratory acceptable to the Architect/Engineer to perform material evaluation tests
 1. Materials and installed Work may require testing and retesting at any time during the progress of the Work. Testing and retesting of rejected materials shall be done at the Contractor's expense
- C. Shotcrete Testing: Test shotcrete for compressive and flexural strength using the following methods:
 1. Prepare test panels and take core samples for testing per the requirements outlined in this section
 2. If test panels were not prepared during construction the Contractor shall take samples for the In-Place Shotcrete:
 - a. Cut a minimum 3 inch (75mm) nominal diameter core from the structure and test in accordance with ASTM C42.
 - b. Do not cut into Steel Reinforcement
 - c. Repair the core hole in the structure
 3. Additional samples from In-Place Shotcrete for Pool shells shall be taken only if directed by the Engineer, and only if any of the test samples from the test panels fail
 4. Strength Evaluation of In-Place core samples:
 - a. If In-Place core samples are taken for testing the mean compressive strength of the core sample must equal or exceed the specified compressive strength, with no individual core less than 85 percent of the specified compressive strength

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Ensure materials and ambient air temperatures are a minimum 50 °F (10 °C) prior to, during, and seven (7) days after the completion of the Work
- B. During freezing or near freezing weather provided equipment and cover to maintain a minimum 50 °F (10 °C) and to protect the Work completed or Work in progress
- C. Suspend shotcrete operation during high winds, rainy weather, or near freezing temperatures, when the Work cannot be protected

PART 2 - PRODUCTS

2.1 SHOTCRETE MATERIALS

- A. Portland Cement: ASTM C150, Type II with C3A ≤ 5% or Type V, provided from one (1) source
- B. Fly Ash: ASTM C618, Type C or F

- C. Normal Weight Aggregates: ASTM C33 and as herein specified. Provide aggregates from a single source for exposed concrete
 - 1. Located aggregates not complying with ASTM C33 but that can be shown by special test or actual service to produce shotcrete of adequate strength and durability may be used when acceptable to the Engineer
 - D. Lightweight Aggregates: ASTM C330
 - E. Mix Water:
 - 1. Clean potable water conforming to ASTM C94
 - 2. Free from deleterious amounts of acids, alkalis, salts, and organic matter
 - F. Pre-Bagged Shotcrete Materials: Proprietary pre-bagged shotcrete materials may be used when proof of satisfactory applications is acceptable to the Engineer
- 2.2 ADMIXTURES
- A. General : Provide Admixtures for shotcrete that contain no more than 0.1 percent chloride ions
 - B. Air-Entraining Admixture: ASTM C260, certified by the Manufacturer to be compatible with all other required admixtures
 - 1. Acceptable Products – Subject to compliance with all requirements:
 - a. Air-Tite by Cormix
 - b. Air-Mix or Perma-Air by Euclid Chemical Company
 - c. Darex AEA or Daravair by W R Grace
 - d. MB-VR or Micro-Air by Master Builders Incorporated
 - e. Sealtight AEA by W R Meadows, Incorporated
 - f. SIKA AER by SIKA Corporation
 - C. Water-Reducing Admixture: ASTM C494, Type A
 - 1. Acceptable Products – Subject to compliance with requirements:
 - a. PSI N by Cormix
 - b. Chemtard by ChemMasters Corporation
 - c. Eucon WR-75 by Euclid Chemical Company
 - d. WRDA by W R Grace
 - e. Pozzolith Normal or Polyheed by Master Builders Incorporated
 - f. Prokrete-N by Protex Industries, Incorporated
 - g. Plastocrete 161 by SIKA Corporation
 - D. High-Range Water Reducing Admixture (Super Plasticizer) ASTM C494, Type F or G
 - 1. Acceptable Products – Subject to compliance with requirements:
 - a. Super P by Anit-Hydro Company
 - b. PSI Super by Cormix
 - c. Eucon 37 by Euclid Chemical Company
 - d. WRDA 19 or Daracem by W R Grace
 - e. Rheobuild by Master Builders Incorporated
 - f. PSP Superplasticizer by Protex Industries Incorporated
 - g. Sikament by SIKA Corporation
 - E. Water Reducing, Retarding Admixture: ASTM C494 Type D
 - 1. Acceptable Products – Subject to compliance with requirements:
 - a. PSI-R Plus by Cormix

- b. Eucon Retarder 75 by Euclid Chemical Company
- c. Daratard-17 by W R Grace
- d. Pozzolith-R by Master Builders Incorporated
- e. Protard by Protex Industries, Incorporated
- f. Plastiment by SIKA Corporation

2.3 MISCELLANEOUS MATERIALS

- A. Surfaces to be finished with tile and/or plaster pool finishes shall not be cured using sealers or curing compounds unless approved by the Engineer and Manufacturers of the finish material and curing compound.
- B. Surfaces where sealers and curing compounds are used will need to be cleaned to remove any such compound from the surface prior to applying finishes
- C. Curing Compound: Liquid membrane-forming curing compound complying with ASTM C309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. m when applied at 200 sq ft/gal (5 sq. m/L)
 - 1. Acceptable Products – Subject to compliance with requirements:
 - a. A-H 3-Way Sealer by Anti-Hydro Waterproofing Company
 - b. Spartan-Cote by the Burke Company
 - c. Conspec #1 by Conspec Marketing and Manufacturing Company, Incorporated
 - d. Hardtop by Cormix
 - e. Day-Chem Cure and Seal by Dayton Superior
 - f. Eucocure by Euclid Chemical Company
 - g. Horn Clear Seal by A C Horn Incorporated
 - h. L & M Cure by L & M Construction Chemicals
 - i. Masterkure CR (Clear) by Master Builders Incorporated
 - j. CS-309 by W R Meadows, Incorporated
 - k. LR-151 by Prokrete Industries
 - l. Kure-N-Seal by Sonneborn-Rexnord
 - m. Stantop CS9 by Stonhard, Incorporated
- D. Bonding Compound: Polyvinyl Acetate or Acrylic Base
 - 1. Acceptable Polyvinyl Acetate (Interior Only) Products:
 - a. Superior Concrete Bonder by Dayton Superior
 - b. Euco Weld by Euclid Chemical Company
 - c. Weldcrete by Larson Products Corporation
 - 2. Acceptable Acrylic or Styrene Butadiene Products:
 - a. Acrylic Bondcrete by The Burke Company
 - b. Day-Chem Ad Bond by Dayton Superior
 - c. SBR Latex by Euclid Chemical Company
 - d. Daraweld C by W R Grace
 - e. Hornweld by A C Horn Incorporated
 - f. Everbond by L & M Construction Chemicals
 - g. Acryl-Set by Master Builders Incorporated
 - h. Intralock by W R Meadows Incorporated
 - i. Sonocrete by Sonneborn-Rexnord
 - j. Stanlock LB2 by Stonhard, Incorporated
- E. Epoxy Adhesive: ASTM C881, two-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements
 - 1. Acceptable Products – Subject to compliance with requirements:

- a. Burke Epoxy M. V. by The Burke Company
- b. Spec-Bond 100 Conspec Marketing and Manufacturing Company, Incorporated
- c. Euco Epoxy 452 or 620 by Euclid Chemical Company
- d. Thiopoxy by W R Grace
- e. Epoxite Binder 2390 by A C Horn Incorporated
- f. Concessive 1001 by Master Builders Incorporated
- g. Sikadur 32 Hi-Mod by Sika Corporation

2.4 PROPORTIONING AND DESIGN OF MIXES

- A. General: Prepare Mix Designs for each type and strength of shotcrete by either laboratory trial batch or field experience methods as specified in ACI 301
 1. If trial batch method is used
 - a. Use an independent testing facility acceptable to the Architect/Engineer for preparing and reporting proposed mix designs
 2. The testing facility shall not be the same as used for field quality control testing
 3. Limit the use of fly ash to a maximum of 25 percent of cement content by weight
 4. Submit written reports to Engineer of each proposed mix for each class of shotcrete at least 15 days prior to the start of the Work
 5. Do not begin shotcrete production until the Engineer has reviewed the proposed mix designs to be in accordance with the Contract Documents and Specifications
- B. Design Mixes to provide Normal Weight Shotcrete with the following properties, or as indicated on the Contract Documents and Schedules
 1. 5,000 psi (34.5 MPa) minimum 28-day compressive strength
 2. Air content, when using wet-mix process, of 6 to 8 percent in the pre-placed mix
- C. Adjustment to Shotcrete Mixes:
 1. The Contractor may request mix design adjustments when characteristics of the material, job conditions, weather, test results, or other circumstances warrant at no additional cost to the Owner and as acceptable by the Architect/Engineer.
 2. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Architect/Engineer before use
- D. Admixtures:
 1. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in shotcrete as required for placement and workability
 - a. Use air-entraining admixture in exterior exposed shotcrete, unless otherwise indicated
 - b. Use Admixtures for water-reducing and set control in strict compliance with the Manufacturer's directions
- E. Develop mix design to give good compaction and low percentage of rebound; stiff enough not to sag when placed vertically
- F. Maintain quality control records during production of shotcrete; records must be made available at all times during construction and submitted at the end of construction

2.5 WATER FEATURE SHOTCRETE EQUIPMENT

- A. Mixing Equipment:
 1. Capable of mixing shotcrete materials in sufficient quantities to maintain continuous placement and thoroughly coating aggregate with cement particles

2. Mixer shall be self-cleaning (i.e. capable of discharging all mixed material without any “carry over” from one batched to the next) and be thoroughly cleaned at least once a day to prevent accumulations of batched material
- B. Air Supply:
1. Provide uniform, steady supply of clean, dry air to maintain constant nozzle velocity while operating blow pipe for cleaning away rebound.
 2. Provide air pressure gauge at outlet of the gun to continuously monitor air pressure at the nozzle in accordance with ACI 506, Table 401c
- C. Wet-Mix Delivery Equipment:
1. Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously
- D. Dry-Mix Delivery Equipment:
1. Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixes material at required velocity to discharge nozzle
 2. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture
 3. Provide water supply with uniform pressure at discharge nozzle sufficiently greater than operating air pressure to ensure complete mixing with the aggregate-cement mixture
 4. Provide water pump to system if line water pressure is inadequate

PART 3 - EXECUTION**3.1 BATCHING AND MIXING**

- A. General:
1. Control mix proportion by weight batching, or by volume batching meeting requirements of ASTM C685
 2. If permitted by the Engineer, other batching procedures may be used provided a minimum of one (1) weight batching check is made every 8 hours or for every 50 cu. yd (38 cu. m) passing through the nozzle to ensure that specified mixture design is achieved
 3. Use batching and mixing equipment capable of proportioning and mixing ingredients (except water in the case of dry-mix equipment) at a rate that provides adequate production and with an accuracy that ensures uniformity of batches
 4. Use weighing equipment capable of batching with accuracy specified in ASTM C94
 5. Use volumetric equipment capable of batching with accuracy specified in ASTM C685. In volume batching, adjust fine aggregate volume for bulking. Test fine aggregate moisture content at least once daily to determine extent of bulking
- B. Ready-Mix Materials:
1. Comply with ASTM C94, except it may be delivered to shotcrete equipment in the dry state if equipment is capable of adding water and mixing it satisfactorily with dry ingredients. Or comply with ASTM C685 when ingredients are delivered dry and proportioned and mixed at site

3.2 SURFACE PREPARATION

- A. Existing Concrete or Masonry
1. Remove unsound material before applying shotcrete
 2. Chip or scarify areas to be repaired to extent necessary to provide a sound substrate
 3. Taper edges to leave no square shoulders at perimeter of cavity. Remove loose material from areas receiving shotcrete

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- 4. Sandblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and provide roughened surface for proper bonding of shotcrete
 - 5. Wet surfaces until damp but without visible free water
 - B. Earth:
 - 1. Compact and trim to line and grade before placing shotcrete
 - 2. Do not place shotcrete on frozen surfaces
 - 3. Dampen surfaces just prior to shotcrete placement
 - C. Rock:
 - 1. Clean rock surfaces of loose material, mud, and other foreign matter that will prevent bond of shotcrete
 - 3.3 INSPECTION
 - A. Refer to overall Project Specification for inspection requirements
 - B. Verify that conditions are acceptable and are ready to receive Work
 - C. Verify fabricated forms are true to line and dimension, adequately braced against vibration during placement, constructed to permit escape of trapped air during gunning operations, and constructed to minimize rebound during gunning operations
 - D. Verify pipes, conduits, box outs, and other penetrations required by other trades are installed and properly anchored and secured prior to applying shotcrete
 - E. Verify that all grounding connections are installed prior to placing concrete. All Steel Reinforcement must be grounded in accordance with the National Electrical Code (NFPA 70)
 - 3.4 ALIGNMENT
 - A. Provide alignment wire to establish thickness and plane of required surfaces
 - B. Install alignment wire at corners and offsets not established by forms
 - C. Tighten alignment wire true to line. Position adjustment devices to permit additional tightening
 - 3.5 JOINTS
 - A. Joints are not allowed in Pool shells. Pool shells are intended to be poured as a continuous and homogeneous shell. Prior approval must be obtained from the Engineer before installing Joints
 - B. Construction Joints
 - 1. Locate and install construction joints as indicated on the Contract Documents or, if not indicated, submit desired location that does not impair strength and appearance of the structure to the Engineer of Record
 - 2. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints where not otherwise shown
 - 3. Fill and seal joints with appropriate materials to provide a water tight joint
 - C. Contraction Joints:
 - 1. Construct contraction joints in slabs-on-ground to form panels of patterns as shown in the Contract Documents
 - 2. Use saw cuts 1/8 inch (3mm) by 1/3 slab depth or inserts 1/4 inch (6mm) wide by 1/3 of shotcrete depth, where not otherwise indicated
 - 3. Form contraction joints by inserting pre-molded plastic, hardboard, or fiberboard strip into fresh shotcrete until top surface of strip is flush with shotcrete surface. Tool edges round on each side of insert. After shotcrete has cured, remove inserts and clean groove of loose debris

4. If joint pattern is not shown, provide joints not exceeding 15 feet (4.5m) in both directions and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays)
5. Fill and seal joints with appropriate materials to provide a water tight joint

3.6 INSTALLATION OF EMBEDDED ITEMS

A. General:

1. Set and build into Work anchorage devices and other embedded items required for other work that is attached to or supported by shotcrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached

B. Edge Forms and Screed Strips for Slabs:

1. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting-type screeds

3.7 WATER FEATURE SHOTCRETE APPLICATION

A. General: Comply with ACI 304 and as herein specified

B. Place concrete on properly prepared undisturbed subgrade materials or engineered fill. Refer to the Geotechnical Soils Report for recommendations

C. Moisten wood forms immediately before placing shotcrete where form coatings are not used

D. Apply temporary protective covering to guard against splattering during placement

E. Direct outlet nozzle perpendicular to surface to ensure maximum compaction with minimum rebound

F. Deposit shotcrete continuously or in layers of such thickness that shotcrete is not placed on material that has hardened sufficiently to cause the formation of seams or planes of weakness

G. Do not permit applied shotcrete to sag, slough, or displace

H. Placing Shotcrete Slabs:

1. Deposit and consolidate shotcrete slabs in a continuous operation until the placing of a panel or section is complete
2. Consolidate shotcrete during placing operations so that shotcrete is thoroughly worked around reinforcement and other embedded items and into corners
3. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not Disturb slab surface prior to beginning finishing operations
4. Maintain reinforcing in proper position and with proper coverage during shotcrete placement operations

I. Cold-Weather Placing:

1. Protect shotcrete Work from physical damage or reduced strength by frost, freezing, or low temperatures in compliance with ACI 306 and as specified
2. When ambient air temperatures has fallen to or is expected to fall below 40 °F (4.4 °C), uniformly heat water and aggregates before mixing to obtain a shotcrete mix temperature of not less than 50 °F (10 °C) and not more than 80 °F (26.7 °C) at point of placement
3. Do not use frozen materials or materials containing ice or snow. Do not place shotcrete on frozen subgrade or on subgrade containing frozen materials
4. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerator unless accepted in the mix designs

J. Hot-Weather Placing:

1. When hot-weather conditions exist that would seriously impair quality and strength of shotcrete, place in compliance with ACI 305 and as specified
2. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 90 °F (32 °C). Mixing water may be chilled, or chopped ice may be used to control temperature provided that water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool shotcrete is the Contractor's option
3. Cover reinforcing steel with water soaked burlap if it becomes too hot, so that steel temperature does not exceed the ambient air temperature immediately before placement
4. Fog spray forms, reinforcing steel, and subgrade just before shotcrete is placed
5. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions

3.8 SURFACE FINISHES

- A. Unexposed Surfaces: Provide natural gun finish unless otherwise indicated
- B. Exposed Surfaces:
 1. Screed smooth areas on exposed face of structures to original plane, then lightly float and trowel for continuous, smooth finish. Remove alignment wires or other alignment control devices
 2. Flash Coat: After screeding, apply a 1/8 to 1/4 inch (3 to 6mm) coat of shotcrete using fine screened sand. Keep application nozzle at a distance greater than required for normal shotcreting
 3. Provide wood float finish after application of flash coat

3.9 CURING AND PROTECTION

- A. Cure surfaces in accordance with ACI 308
- B. General : Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures
- C. Start initial curing as soon as free water has disappeared from shotcrete surface after placing and finishing using the following approved methods
 1. Horizontal Surfaces
 - a. Wet Curing by Ponding: Maintain 100 percent coverage of water over floor slab areas maximum 1/4 inch (6mm) deep
 - b. Wet Curing by Spraying: Spray water over floor slab area as required to prevent surface drying
 2. Vertical Surfaces
 - a. Wet Curing with Burlap Sacks: Place burlap sacks over the entire surface, wet sacks as required to prevent surface drying
 - b. Wet Curing by Spraying: Spray water over floor slab area as required to prevent surface drying
- D. Continue curing placed shotcrete and maintain surface wetting for at least seven (7) days using the method described in this section or as approved by the Engineer
- E. Curing compounds may not be used, unless specifically approved by the Engineer prior to application

3.10 REMOVAL OF FORMS

- A. Forms not supporting weight of shotcrete may be removed after 24 hours if shotcrete has cured at temperatures greater than 50 °F (10 °C) and provided shotcrete is sufficiently hard that it will not be damaged by form removal operations and provided curing and protection operations are maintained

- B. Forms supporting weight of shotcrete may not be removed in less than 14 days and until shotcrete has attained design minimum compressive strength at 28-days. Determine potential compressive strength of In-Place shotcrete by testing field-cured specimens representative of shotcrete location or members
- C. Form-facing material may be removed four (4) days after placement only if shores and other vertical supports have been arranged to permit removal without loosening or disturbing shores and supports

3.11 REPAIR OF DEFECTS

- A. Remove and replace shotcrete that lacks uniformity, or exhibits segregation, honeycomb, delamination, or contains dry patches, single voids in excess of 1/2 inch (12mm) in any direction or sand pockets
- B. Perform a sounding test to the applied material with a hammer for voids. Expose voids and replace with new shotcrete ensuring full bond with adjacent Work
- C. Remove over spray and rebound material that does not fall clear of Work; discard salvaged rebound

END OF SECTION

SECTION 13 1302 – WATER FEATURE TILE FINISHES

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Waterline Tile
 - 2. Nosing Tile
 - 3. Depth and Safety Markers
 - 4. Mosaic Tiles
 - 5. Pool Coping
 - 6. Adhesives and Grout
- B. Related Sections:
 - 1. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 2. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 3. SECTION 13 1301 – WATER FEATURE PLASTER FINISHES
 - 4. SECTION 13 1305 – WATER FEATURE ACCESSORIES
 - 5. SECTION 13 1404 – WATER FEATURE WHITE GOODS
- C. References:
 - 1. ANSI A108.4 – CERAMIC TILE INSTALLED WITH ORGANIC OR EPOXY ADHESIVES
 - 2. ANSI A108.6 – CERAMIC TILE INSTALLED WITH CHEMICAL EPOXY MORTAR GROUT
 - 3. ANSI A118.3 – SPECIFICATION FOR CHEMICAL RESISTANT, WATER CLEANABLE TILE-SETTING AND GROUTING ADHESIVE
 - 4. ANSI A118.4 – FAST-SETTING LATEX HYDRAULIC THIN-SET MORTAR AND LATEX PORTLAND CEMENT MORTAR
 - 5. ANSI A137.1 – STANDARD SPECIFICATION FOR CERAMIC TILE
 - 6. HANDBOOK FOR CERAMIC TILE INSTALLATION

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Tile Product Data: Submit manufacturer's literature and product data, specifications, installation instructions, cleaning instructions, and recommended stain removal methods for each type of Tile and Coping
- C. Grout Product Data: Submit manufacturer's literature and product data, specifications, and instructions for using mortars, adhesives, and grouts
- D. Shop Drawings: Provide a shop drawing indicating tile and coping layout, patterns, color arrangement, terminating edge conditions, and setting details
- E. Samples:
 - 1. Samples shall be approved by the Architect/Landscape Architect
 - 2. Submit representative color samples of each type and size of tile
 - 3. Submit a 12 x 12 inch (0.3 x 0.3m) sample of coping with finish edge conditions
 - 4. Upon final selection, submit tile mock-up on a plywood backer board, illustrating tile patterns and colors, grout joint widths and colors, and maximum color variations anticipated.
 - a. Size of mock-up to allow for at least four (4) tiles, minimum 12 by 12 inches (0.3 x 0.3m)
- F. Grout Samples:
 - 1. Submit manufacturer's full range of standard and designated color samples for each type of designer's selection for review by the Architect/Landscape Architect

2. Submit samples mounted in a 6 inch (150mm) long metal channel for each type and color specified for review by the Architect/Landscape Architect
- G. Tile Certifications: Submit "Master Grade Certificate" for each type of ceramic tile in accordance with requirements of ANSI A137
- H. Grout Certifications: Submit manufacturer's certifications that mortars, adhesives, and grouts are suitable for use in swimming pools, hot tubs, and/or fountains
- I. Special Project Warranty: Submit a written warranty, executed by the Contractor, Installer, and Manufacturer, agreeing to repair or replace materials that fail in material or workmanship within two (2) years after date of Substantial Completion
- 1.3 FIELD SAMPLES
 - A. Construct and install field samples of approximately 50 sq ft (4.6 sq. m) of each type of tile and grout for final review.
 - B. Show workmanship of finished work and construction techniques
 - C. Approved field samples may remain as part of the Work
- 1.4 QUALITY ASSURANCE
 - A. Manufacturer Qualifications: Company specializing in manufacturing of pool tile products having a minimum of five (5) years experience
 - B. Installer Experience: Company specializing in performing the work of this section with minimum of five years experience
 - C. Single Source Supplier: Obtain tile and grout materials from single source manufacturer to ensure uniformity and compatibility
- 1.5 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver materials in manufacturer's unopened containers, fully identified with name, brand, type, and grade
 - B. Protect materials from contamination, dampness, freezing, or overheating in accordance with the manufacturer's instructions
 - C. Broken, cracked, chipped, stained, or damaged tile will be rejected, whether built-in or not
 - D. Protect mortar and grout from moisture, soiling, staining, freezing, or overheating in accordance with manufacturer's instructions
- 1.6 ENVIRONMENTAL REQUIREMENTS
 - A. Comply with requirements of material manufacturer's recommendations and reference standards for environmental conditions before, during, and after installation
 - B. Maintain temperatures of not less than 50 °F (10 °C) or more than 95 °F (35 °C) during installation of tile and mortar materials and for seven (7) days after completion, unless higher temperatures are required by ANSI Installation Standards or manufacturer's written instructions
 - C. When necessary, build temporary shelters and use indirect auxiliary heaters to maintain adequate temperature level in working environment. Exhaust temporary heaters to an exterior location to prevent damage to work from carbon dioxide emissions
- 1.7 EXTRA MATERIALS
 - A. Provide at least two percent (2%) of each size, color, and surface finish of each type of tile specified to be delivered to the Owner

- B. Store in location as directed by the Owner

PART 2 - PRODUCTS

2.1 TILE MANUFACTURERS

- A. Waterline Tile
 - 1. Dal-Tile
 - 2. Alpha Tile
 - 3. Bolart Custom Tile
 - 4. Crevill, Incorporated
 - 5. Approved Alternate
- B. Nosing Tile
 - 1. Dal-Tile
 - 2. Tile Specialties – High Springs, Florida
 - 3. Approved Alternate
- C. Depth and Safety Markers
 - 1. Inlays, Incorporated
 - 2. Agape Tile Manufacturers
 - 3. Degroot Studios, Incorporated
 - 4. Approved Alternate
- D. Mosaic Tile
 - 1. Alpha Tile
 - 2. Agape Tile Manufacturers
 - 3. Artistry in Mosaics
 - 4. Bolart Custom Tile
 - 5. Dal-Tile
 - 6. Degroot Studios, Incorporated
 - 7. Graphic Tile
 - 8. Innovative Marble and Tile
 - 9. Interstate Ceramic and Glass
 - 10. Kolorines
 - 11. Renato Misazza, Incorporated
 - 12. Swedecor Specialist
 - 13. Talisman Tiles
 - 14. Approved Alternate
- E. Pool Coping
 - 1. DC Kerckhoff
 - 2. Federal Stone
 - 3. Wausau Tile
 - 4. Approved Alternate
- F. Adhesives and Grouts
 - 1. Mapei Corporation
 - 2. Laticrete International, Incorporated
 - 3. Dal-Tile

2.2 FINISH SPECIFICATIONS

- A. Pool Tile Finish

1. Pool Coping
 - a. Material: Pre-cast Coping
 - b. Color: Specified by Architect/Landscape Architect
 - c. Size: 12 x 24 inches (0.3 x 0.6m)
 - d. Edge Style: Rounded Handhold
 2. Waterline Tile:
 - a. Material: Glazed, glossy finish, ceramic tile
 - b. Color: Specified by Architect/Landscape Architect
 - c. Pattern: Specified by Architect/Landscape Architect
 - d. Size: 6 x 6 inches (150 x 150mm)
 3. Mosaic Tile
 - a. Material: Glazed, semi-gloss finish, slip resistant, glass tile
 - b. Pattern: Specified by Architect/Landscape Architect
 - c. Size: ¾ x ¾ inches (19 x 19mm)
 4. Nosing Tile:
 - a. Material: Unglazed or glazed, slip resistant, ceramic tile
 - b. Color: Specified by Architect/Landscape Architect
 - c. Pattern: Specified by Architect/Landscape Architect
 - d. Size: 2 x 6 inches (50 x 150mm)
 - e. Edge Style: Bull nose
 5. Depth and Safety Markers:
 - a. Material: Glazed, semi-gloss finish, slip resistant, ceramic tile
 - b. Pattern:
 - i. Depth Marker: 4 inch (0.1m) tall solid black letters on white background
 - ii. Safety Marker: black letters, red symbol on white background
 - c. Font: Arial
 - d. Size: 6 x 6 inches (150 x 150mm)
- B. Spa Tile Finish
1. Pool Coping
 - a. Material: Pre-cast Coping
 - b. Color: Specified by Architect/Landscape Architect
 - c. Size: 12 x 24 inches (0.3 x 0.6m)
 - d. Edge Style: Rounded Handhold
 2. Waterline Tile:
 - a. Material: Glazed, glossy finish, ceramic tile
 - b. Color: Specified by Architect/Landscape Architect
 - c. Pattern: Specified by Architect/Landscape Architect
 - d. Size: 6 x 6 inches (150 x 150mm)
 3. Nosing Tile:
 - a. Material: Unglazed or glazed, slip resistant, ceramic tile
 - b. Color: Specified by Architect/Landscape Architect
 - c. Pattern: Specified by Architect/Landscape Architect
 - d. Size: 2 x 6 inches (50 x 150mm)
 - e. Edge Style: Bull nose

4. Depth and Safety Markers:
 - a. Material: Glazed, semi-gloss finish, slip resistant, ceramic tile
 - b. Pattern:
 - i. Depth Marker: 4 inch (0.1m) tall solid black letters on white background
 - ii. Safety Marker: black letters, red symbol on white background
 - c. Font: Arial
 - d. Size: 6 x 6 inches (150 x 150mm)
- C. Lazy River Tile Finish
 1. Pool Coping
 - a. Material: Pre-cast Coping
 - b. Color: Specified by Architect/Landscape Architect
 - c. Size: 12 x 24 inches (0.3 x 0.6m)
 - d. Edge Style: Rounded Handhold
 2. Waterline Tile:
 - a. Material: Glazed, glossy finish, ceramic tile
 - b. Color: Specified by Architect/Landscape Architect
 - c. Pattern: Specified by Architect/Landscape Architect
 - d. Size: 6 x 6 inches (150 x 150mm)
 3. Nosing Tile:
 - a. Material: Unglazed or glazed, slip resistant, ceramic tile
 - b. Color: Specified by Architect/Landscape Architect
 - c. Pattern: Specified by Architect/Landscape Architect
 - d. Size: 2 x 6 inches (50 x 150mm)
 - e. Edge Style: Bull nose
 4. Depth and Safety Markers:
 - a. Material: Glazed, semi-gloss finish, slip resistant, ceramic tile
 - b. Pattern:
 - i. Depth Marker: 4 inch (0.1m) tall solid black letters on white background
 - ii. Safety Marker: black letters, red symbol on white background
 - c. Font: Arial
 - d. Size: 6 x 6 inches (150 x 150mm)
- 2.3 GENERAL MATERIAL PROPERTIES
 - A. All Tiles:
 1. Single manufacturer for each type, variety, and color for each pool
 2. Frost resistant
 3. Resistant to chemical attack
 4. Water absorption of 0.5% or less
 5. Colors shall be resistant to fading
 6. Designed to be used in a swimming pool or spa environment
 7. Tiles placed on horizontal surfaces shall be slip resistant
 - B. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

1. Match Designer's sample, if provided
 2. Provide tile trim and accessories that match color and finish of adjoining tile unless noted otherwise
- C. Factory Blending: For tile exhibiting color variations within the ranges selected during sample submittal, blend tile in the factory and package accordingly, so that tile units taken from one package show the same range in color as those taken from other packages and match the approved samples
- D. Mounting: Do not use back or edge mounted tile assemblies unless tile manufacturer specifies that the type of mounting is suitable for the application and has been successfully used on other projects
- 2.4 CERAMIC TILES
 - A. Comply with ANSI A137.1 for types, compositions, and grades of tile indicated
- 2.5 Mosaic Tiles
 - A. Glass Mosaic Tiles: Tile shall be impervious glass tiles, textured backs for adhesive grip, beveled edges for smooth corners, and smooth face
 1. Jagged or sharp edges are unacceptable
- 2.6 Setting Materials
 - A. Flexible Acrylic Latex Portland Cement Mortar: KERABOND/KERALASTIC, white color, two component flexible mortar system conforming to ANSI A118.4 standards, as manufactured by Mapei or approved equal
 - B. Flexible Fast Setting Latex Hydraulic Mortar: KER 318 GRANI/RAPID, white color, two component flexible latex hydraulic thin-set mortar conforming to ANSI A118.10 standards, as manufactured by Mapei or approved equal
- 2.7 GROUTING MATERIALS
 - A. Sanded Tile Grout: KER 200 polymer-modified sanded Portland cement grout conforming to ANSI A118.6 standards, as manufactured by Mapei or approved equal. Color shall be approved by Architect/Landscape Architect
 - B. Fast-Curing Sanded Grout: KER 700 Ultra/Color polymer-modified hydraulic sanded tile grout conforming to ANSI A118.6 standards, as manufactured by Mapei or approved equal. Color shall be approved by Architect/Landscape Architect
 - C. Water: Clean, Cold, Potable Water
- 2.8 Waterproof Barrier
 - A. Waterproofing compound as recommended by the tile manufacturer

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Verify concrete surface to receive tile finish has been cured a minimum of 28 days prior to installing tiles, mortar beds, and grout
 - B. Verify no sealer or curing compounds were used on concrete surfaces to be covered with tile and that the concrete surfaces have been finished with a wood float.
 1. The Contractor shall be responsible for the removal of any such contamination that may prevent or reduce adhesion by bead-blasting or sand-blasting. Then wetting down or washing the entire surface and removing excess water prior to application of mortar bed
 - C. Verify anchors, escutcheons, caps, covers, jets, inlets, light fixture housings, and other embedded items are installed prior to proceeding with the Tile Work

- D. Verify that areas to receive tile installed by thin-set bed method have a wood float finish, are true within ¼ inch (6mm) in 10 feet (3m), and are pitched to drains where required
- E. Verify surfaces to be finished are free of dirt, dust, loose particles, oils, grease, and foreign matter that may affect bonding

3.2 PREPARATION

- A. Prepare surfaces in strict accordance with instructions of the manufacturer whose setting materials or additives are being used
- B. Scarify concrete substrates with blast track equipment, if necessary, to completely remove curing compounds or other substances that would interfere with proper bond of setting materials
- C. Apply waterproofing membrane over the entire area where tile is to be installed in strict accordance with the manufacturer's recommendations. Grout and tile do not constitute a waterproof barrier

3.3 GENERAL INSTALLATION

- A. Install tile material in strict accordance with the manufacturer's application guidelines and recommendations and in accordance with ANSI A137.1
- B. When installing large tiles, ceramic or mosaic, trowel small quantity of mortar or adhesive onto the back of each tile or sheet of tiles, lay tile to pattern. Do not interrupt tile pattern through openings, cut tile insuring tight fit. Ensure finish trim will cover cut tile edges
- C. Cut and fit tile tight to protrusions and vertical interruptions. Form corners and bases neatly. Form internal angles coved and external angles bull nosed

3.4 LAYOUT

- A. Layout work to pattern indicated so that full tile or joint is centered on each wall and no tiles of less than half width need be used. Do not interrupt pattern through openings. Layout tile to minimize cutting and to avoid tile less than half size
- B. No staggered joints in the tile will be allowed
- C. Align joints in both directions
- D. Align joints between the floor and wall tiles
- E. Make joints between sheets of tile exactly the same width as joints within the sheet
- F. Cut and fit tile at penetrations through tile. Do not damage the visible surface of the tile. Carefully grind edges of tile abutting built-in items. Fit tile at all pipe and fitting penetrations, insure covers overlap cut tiles
- G. Extend tile work into recesses, inside gutters, and behind fixtures, to form a complete covering without interruptions. Terminate work neatly at obstructions, edges, and corners with disrupting the pattern or joint alignments

3.5 TILE INSTALLATION

- A. Thin-Set Installation Option
 - 1. Apply mortar or adhesive with notched trowel using a scraping motion to work material into good contact with surface to be covered and in strict accordance with the manufacturer's recommendation. Maintain 90% coverage on the back of the tile and fully bed all corners
 - 2. Apply only as much mortar or adhesive as can be covered within allowable windows as recommended by mortar or adhesive manufacturer on while surface is still tacky
 - 3. Set tile or sheet of tiles in place and beat tile with wooden block. Beat or rap tile to ensure proper bond and also to level surface of tile
 - 4. Align tile to show uniform joints between all tiles and allow to set until firm

5. Clean excess mortar or adhesive from surface of tile with wet cheese cloth (no sponges will be allowed) while the mortar is fresh
6. Allow face mounted tile to set until firm before removing paper and before grouting
7. Sound tile after setting. Replace hollow sounding tiles
8. Allow tile to set for a minimum of 48 hours prior to grouting. After tile has set, grout tile joints

B. Thick Bed Installation Option

1. Apply slurry bond coat (scratch coat) approximately 1/16 inch (1.5mm) thick to substrate surface using a flat trowel
2. Place thick bed mortar, 3/4 to 1-1/4 inch (19 to 32mm) thick nominally onto slurry bond coat while coat is still wet and tacky. Apply rod and float mortar bed to a uniform plumb and level surface
3. Apply mortar bed over an area that can be covered by tile before mortar dries. Do not let mortar bed dry or place tile on a dried mortar bed
4. Before placing tiles on green or wet mortar bed, apply waterproof slurry bond coat approximately 1/16 inch (1.5mm) thick to mortar using a flat trowel
5. Apply water proof slurry coat to back of each tile or sheet of tile immediately prior to placing on bed. Place tiles in wet slurry coat before surface dries maintaining uniform joints
6. After each tile or sheet of tiles is laid, beat tile with wooden block to level surface and embed tiles into slurry coat. Move block in diagonal movements in a manner to prevent misalignment of the tiles or sheet lines. Immediately correct uneven or misaligned tiles.
7. Place each tile or sheet of tiles into place insuring the separation between tiles is uniformly the same between all tiles on the sheet
8. Sound tiles after setting. Replace hollow sounding tiles
9. Clean excess mortar or adhesive from surface of tile with wet cheese cloth (not a sponge) with mortar is fresh
10. After tile has set, grout tile joints

3.6 EXPANSION AND CONTROL JOINTS

- A. Install control joints where the tile abuts restraining surfaces, around the perimeter of the tile work and where two substrates of different compositions meet in the same place
- B. Install and space expansion and control joints in all directions in strict accordance with the instructions of the Tile Council of America's Detail #EJ-171 as described in the latest edition of their "Handbook for Ceramic Tile Installation". Expansion joints shall be raked or cut through the setting bed to the supporting slab or structure
- C. Do not cut expansion and control joints after the tile has been installed. The installer should tile to the joint and stop. If required, cut the tile and commence tiling from the opposite side. Before continuing rake the joint clean

3.7 GROUTING

- A. Allow tile to set a minimum of 48 hours prior to grouting, or in accordance with the manufacturer's installation instructions
- B. After the tile has set, install grout in accordance with the manufacturer's recommendations
- C. Pack joints full and free before mortar takes initial set. Clean tiles completely leaving no apparent cement laitance or epoxy film on the surface. Do not acid wash
- D. Seal grout in accordance with the manufacturer's recommendations. Insure sealer, if used, is compatible with the tile finish

3.8 PROTECTION

- A. Protect finish Work against weather, freezing, and complete water immersion for at least 72 hours after completion of the Work. Do not immerse in water until full setting has occurred as recommended by the manufacturer
- B. Protect finished work from damage due to traffic, impact, vibration, hammering, etc. for a minimum of 72 hours after installation
- C. Protect Work so that it will be without any evidence of damage or use at time of acceptance

END OF SECTION

SECTION 13 1304 – WATER FEATURE ELASTOMERIC WATERPROOFING

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Surface Preparation
 - 2. Application of Elastomeric Waterproofing
 - 3. Testing
 - 4. Repairing
- B. Related Sections:
 - 1. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 2. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 3. SECTION 13 1401 – WATER FEATURE PVC AND HDPE PIPE AND FITTINGS
 - 4. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
- C. Reference
 - 1. ASTM C836 – STANDARD SPECIFICATION FOR HIGH SOLIDS CONTENT, COLD LIQUID-APPLIED ELASTOMERIC WATERPROOFING MEMBRANE
 - 2. ASTM D412 – STANDARD TEST METHOD FOR VULCANIZED RUBBER AND THERMOPLASTIC ELASTOMERS
 - 3. ASTM D624 – STANDARD TEST METHOD FOR TEAR STRENGTH OF CONVENTIONAL VULCANIZED RUBBER AND THERMOPLASTIC ELASTOMERS
 - 4. ASTM D2240 – STANDARD TEST METHOD FOR RUBBER PROPERTY-DUROMETER HARDNESS
 - 5. ASTM E96 METHOD E – STANDARD TEST METHODS FOR WATER VAPOR TRANSMISSION OF MATERIALS

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Provide manufacturer's product literature and installation instructions, including surface preparation procedures, handling, storage, application, protection and care, and repairs
 - 1. Provide manufacturer's product literature for fillers, flashings, and sealants that may be required as part of the Work
- C. Sample: Provide five (5) 4 x 4 inch (100 x 100mm) samples of membrane of the thickness, color, and texture as specified in this section and as shown on the Contract Documents
- D. License Certificate: Provide a currently dated applicator's license certificate issued by the manufacturer verifying the applicator's qualifications to install the product and acceptance of the manufacturer to fully warrant the product
- E. As-Built Plans: Submit at the end of construction an as-built plan showing the location and date of repairs, patches, and cold joints in the elastomeric waterproofing membrane
- F. Warranty: Provide a written warranty executed by the manufacturer and the Installer, agreeing to repair or replace failures in the membrane that occur within ten (10) years after the date of final payment

1.3 QUALITY ASSURANCE

- A. Applicator: Company specializing in performing the Work of this section having a minimum of five (5) years of experience with project of similar size and scope

- B. Single Source Responsibility: Provide primers, and other undercoat materials produced by the same manufacturer as the finish coats. Provide coatings for the entire project from only one manufacturer and supplier

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to the job site in the manufacturer's original, new, unopened containers clearly marked with the supplier's name, brand name, and type of material
- B. Storage and Handling: Store containers in a well-ventilated, clean, dry, and covered area.
 - 1. Do not store in direct sunlight.
 - 2. Avoid contamination with water or moisture
 - 3. Keep all containers tightly closed until ready for use
 - 4. Handle products to avoid damaging containers

1.5 PROJECT CONDITIONS

- A. Environmental Conditions:
 - 1. Apply coatings only when the temperature of the surfaces to be coated and surrounding air temperatures are above 50 °F (10 °C), unless otherwise permitted by the manufacturer's printed instructions
 - 2. Do not apply coatings under any of the following conditions:
 - a. In rain, fog, or mist
 - b. When relative humidity exceeds 85%
 - c. At temperatures less than 5 °F (3 °C) above dew point
 - d. To damp or wet surfaces
- B. Safety and Health Conditions:
 - 1. Provide adequate ventilation during application of the materials to protect the applicator from breathing vapors and prevent contact with the skin or eyes
 - 2. Wear approved protective clothing, respirator, and gloves during application
- C. Protection:
 - 1. Keep all products away from heat, sparks, and flames during application and curing. Do not allow spark producing equipment, i.e. welders, torches, etc. during application and until all vapors are dissipated
 - 2. Vapors from solvents can carry considerable distances and care should be taken to post "WARNING" signs, "CAUTION" tapes, and "NO SMOKING" signs, etc. within a minimum 100 feet (30m) from the Work area

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers
 - 1. CIM Industries, Incorporated
 - 2. Perma-Gard III by Neogard Division of Jones-Blair Company
 - 3. EnviroLastic by Sherwin-Williams Industrial & Marine
- B. Minimum Physical Properties:

Properties	Test Method	Values
Tensile Strength, psi / MPa	ASTM D412	1,000 / 6.9
Elongation at Break, min %	ASTM D412	300%
Tear Strength, psi / MPa	ASTM D624 (DIE C)	180 / 1.2

Moisture Vapor Transmission
Shore Hardness

ASTM E96 METHOD E
ASTM D2240

0.03 perms / 100 mil
65

2.2 ELASTOMERIC COATING SYSTEMS

- A. Elastomeric coating shall be a tough, corrosion and chemical resistant cold fluid-applied waterproofing membrane specifically for use in water applications
- B. The elastomeric coating shall contain a minimum of 88% solids by volume and be a fast cure two-component, aromatic, protective membrane
- C. All additives utilized for strength, flexibility, and inhibiting ultraviolet (UV) degradation, shall be especially developed for submerged environmental conditions

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that the concrete work and rockwork has been properly placed, troweled smooth, and cured for a minimum of 28 days prior to application.
 - 1. Concrete and rockwork should be water cured without the uses of concrete curing agents
 - 2. If concrete curing agents were used contact the manufacturer for recommendations prior to applying the product
- B. Examine the concrete and rockwork surfaces where the elastomeric coating systems will be applied, for compliance with the manufacturer's application requirements. Verify surfaces do not contain voids, gaps, or "honey-comb" surfaces and is free of ridges and sharp projections. Verify that the surfaces are thoroughly dry
- C. Verify piping or conduits that penetrate the elastomeric waterproofing membrane is installed a minimum of 6 inches (150mm) above or through the concrete or rockwork surface

3.2 PREPARATION

- A. Concrete and rockwork surfaces shall be smooth and free of defects. Grind burs and excess concrete as required, chip and fill voids and "honey-combs" as required
- B. Cracks: Visible hairline cracks in concrete, up to 1/16 inch (1.5mm) in width, shall be cleaned and treated with bitumen-modified polyurethane coating material a minimum distance of 2 inches (50mm) on each side of the crack to yield a thickness of 30 dry mils minimum. Large cracks, over 1/16 inch (1.5mm) in width, shall be detailed with sheet flashing
- C. Cold Joints and Control Joints: All cold joints occurring in floors, walls, and where two or more concrete edges intersect shall be free of excess concrete and burs, then detailed with sealant and sheet flashing. All control joints shall be detailed with sheet flashing
- D. Building Expansion Joints: Building expansion joints shall be filled with silicon and covered with a sheet flashing a minimum of 6 inches (150mm) each side of the expansion joint. The sheet flashing shall be installed loosely allowing 1 inch (25mm) overlap across the expansion joint
- E. Pipe Penetrations: All pipe penetrations that extend through the surface where elastomeric waterproofing membrane is installed shall have non-shrink grout installed if necessary between the link seal and the finished surface. Liquid Flashing or sheet flashing shall be placed around all pipe penetrations as recommended by the manufacturer
- F. Cleaning: All surfaces shall be free from oil, grease, loose powder, debris, and dust. Thoroughly wash the surface with a power broom and strong non-sudsing detergent, rinse and dry prior to application or as directed by the manufacturer
- G. Corners, cracks, construction joints, and control joints shall be clean and free of oil, grease, loose powder, debris, and dust prior to applying waterproofing

3.3 APPLICATION

- A. Priming: Apply base coat or bonding agents as recommended by the manufacturer
- B. Apply elastomeric waterproofing by brush, roller, or sprayer according to the manufacturer's recommendations
- C. Apply an even, continuous 100 mil layer of waterproofing over the entire water feature, including horizontal, vertical, and sloped concrete surfaces and/or over smoothed rockwork surfaces as indicated on the Contract Documents
- D. The waterproofing shall extend beyond the limits of the water feature as indicated in the Contract Documents
- E. Where flashing is used to cover cracks, construction joints, or control joints the waterproofing shall be applied in a continuous manner over the flashing. The waterproofing should completely cover liquid and sheet flashing. Field seams at flashings will not be accepted
- F. In locations where pipe penetrates the waterproofing, the waterproofing membrane shall be applied completely around the pipe, covering the flashing, and extending along the pipe a minimum of 1 inch (25mm) above the flashing for pipes 4 inches (100mm) or less in diameter, and 3 inches (75mm) above the flashing for pipes greater than 4 inches (100mm) in diameter
- G. Waterproofing shall be terminated at the edges in a manner that prevents the cured membrane from "peeling" off the surface to which it was applied

3.4 TESTING

- A. After the waterproofing membrane has cured, visually inspect the waterproofing for defects and damage
- B. Cap and support all pipe penetrations through the waterproofing prior to testing the waterproofed areas. Install plugs in all drains
- C. Completely fill areas where waterproofing has been applied to the water level indicated on the Contract Documents
- D. The elastomeric waterproof membrane area shall be flood tested for 48 hours after the system has cured and prior to installation of any protection course
- E. Repair any leaks or damaged areas that may appear

3.5 PATCHING, REPAIRING, AND COLD JOINTS

- A. Patching, repairing, and cold joints shall be performed in strict compliance with the manufacturer's recommendations
- B. The location and date of any patches or repairs shall be noted on an as-built plan by the applicator and construction manager. The location of cold joints shall also be noted on the as-built plan

3.6 PROTECTION

- A. Install protection boards as required to protect the installed waterproofing membrane from damage during construction. Protection boards are not to be considered as adequate protection from welding sparks, slag, etc
- B. Only authorized individuals shall be allowed to walk or work upon the waterproofing membrane and only when wearing soft-sole shoes
- C. Protect membrane from welding sparks, slag, etc. If welding does occur in the area where the membrane has been installed and has not been protected by a permanent covering and additional water test, as described in this section will be required before the permanent protective covering can be installed.

- D. Immediate after the water test has been performed and any repairs made, the waterproofing membrane shall be covered. If any additional welding occurs before the entire liner has been covered, an additional water test will be required until the entire waterproofing membrane has been protected with a permanent covering

END OF SECTION

SECTION 13 1305 – WATER FEATURE ACCESSORIES

PART 1 - GENERAL**1.1 SUMMARY****A. This section includes the following:**

1. Underwater Light Fixtures
2. Handrails
3. Ladders
4. Portable Vacuum Systems
5. Pool Access Lifts
6. Thermal Pool Covers
7. Lane Dividers, Anchors, and Safety Lines
8. Starting Platforms
9. Maintenance Kit
10. Safety Kit
11. Safety Signage

B. Related Sections:

1. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
2. SECTION 13 1205 – WATER FEATURE SHOTCRETE
3. SECTION 13 1301 – WATER FEATURE PLASTER FINISHES
4. SECTION 13 1302 – WATER FEATURE TILE FINISHES
5. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
6. SECTION 13 1404 – WATER FEATURE WHITE GOODS
7. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
8. SECTION 13 1503 – WATER FEATURE FILTERS
9. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
10. SECTION 13 1608 – WATER FEATURE UNDERWATER LIGHTING CONTROLS
11. SECTION 13 1611 – WATER FEATURE GROUNDING

C. References:

1. ASTM A967 – STANDARD SPECIFICATION FOR CHEMICAL PASSIVATION TREATMENTS FOR STAINLESS STEEL PARTS
2. ASTM D751 – STANDARD TEST METHODS FOR COATED FABRICS
3. ASTM D3773 – STANDARD TEST METHODS FOR LENGTH OF WOVEN FABRICS
4. ASTM D3774 – STANDARD TEST METHODS FOR WIDTH OF WOVEN FABRICS
5. ASTM D3775 – STANDARD TEST METHODS FOR WARP (END) AND FILLING (PICK) COUNT OF WOVEN FABRIC
6. ASTM D3776 – STANDARD TEST METHODS FOR MASS PER UNIT AREA (WEIGHT) OF FABRIC
7. ASTM G154 – STANDARD PRACTICE OF OPERATING FLUORESCENT ULTRAVIOLET LAMP APPARATUS FOR EXPOSURE TO NONMETALLIC MATERIALS
8. National Sanitation Foundations (NSF) – Standard 50 Specifications
9. National Fire Protection Association (NFPA) 70 – National Electrical Code (NEC) – Article 680-21
10. Underwriters Laboratories (UL)
11. 2010 ADA Standards for Accessible Designs

1.2 SUBMITTALS FOR REVIEW**A. SECTION 01 3300 – SUBMITTAL PROCEDURES**

- B. Product Data Sheets:** Submit manufacturer's product data sheets on all products contained in this section for approval. Data sheets must substantiate conformance with applicable standards and include printed recommendations, dimensions, ratings, and capacities.

1. Indicate on submittal which materials, models, data, ratings, and options are being selected
- C. Shop Drawings: Indicate layout, general assembly, components, dimensions, clearances, and method of assembly.
- D. Maintenance Data: Include manufacturer's literature, maintenance recommendations, and replacement parts list.
- 1.3 DELIVERY, STORAGE, AND HANDLING
 - A. Accept components on site in factory packing and inspect for damage
 - B. Protect all components received at site from physical damage, including effects of weather, water, and construction

PART 2 - PRODUCTS

- 2.1 Underwater Light Fixtures
 - A. Incandescent Fixtures
 1. Acceptable Manufacturers
 - a. Hydrel – Model 4425 SWM or 4800 SWM
 - b. Pentair – Amerilite or SpaBrite
 - c. Jandy – White Pool or Spa Light
 2. Niche
 - a. Stainless Steel, Cast Bronze, or High Strength PVC with provisions for positive locking of fixture in position
 - b. Minimum of four tie locations to form work or steel structural rods
 - c. Pressure grounding lug on interior and exterior surfaces
 - d. Conduit entrance shall be 3/4" (20mm) NPT with 3/4" x 1/2" (20mm x 12mm) NPT reducer bushing supplied
 - e. Niche shall be appropriately sized to the fixture
 3. Lamp
 - a. 12 Volt, PAR56, 300 Watt maximum
 - b. 12 Volt, MR-16, 75 Watt maximum, Quartz Halogen
 4. Socket
 - a. 12 Volt, ring terminal connectors with 200 °C insulated leads (for PAR56 Lamps)
 - b. 12 Volt, bipin mount GX5.3 (for MR-16 Lamps)
 5. Lens
 - a. Heat resistant tempered glass with 30° spread and 15° downward deflection
 6. Gasket
 - a. Single-piece molded U-shape silicone
 7. Cord
 - a. Minimum 35 feet (10.7m) of #10-3 STW for US Standard
 - b. Cord entrance shall be brass, water-tight seal and epoxy encapsulated
 - c. Contractor shall determine the required cord length prior to ordering the fixture
 - d. Sufficient cord must be coiled in the niche to allow for the removal of the fixture to above water level for relamping
 8. Factory Leak Tested

- a. All fixture shall be tested at 10 PSI (0.7 kPa) internal pressure while total submerged in water
 9. Low Water Cut-Off
 - a. Temperature sensing Low Water Cut-Off standard
- B. White LED Fixtures
 1. Acceptable Manufacturers
 - a. Pentair – Intellibrite 5G
 - b. Hydrel – Model 4426 LED Monochromatic
 2. Niche
 - a. Stainless Steel, Cast Bronze, or High Strength PVC with provisions for positive locking of fixture in position
 - b. Minimum of four tie locations to form work or steel structural rods
 - c. Pressure grounding lug on interior and exterior surfaces
 - d. Conduit entrance shall be 3/4" (20mm) NPT with 3/4" x 1/2" (20mm x 12mm) NPT reducer bushing supplied
 - e. Niche shall be appropriately sized to the fixture
 3. LED Type
 - a. System shall be composed of two components
 - i. LED Array Board
 - ii. Driver
 - b. Lamp life shall be rated at a minimum 50,000 hours
 - c. LED light shall be capable of producing a 100 to 300 Watt incandescent equivalency
 4. Voltage shall be 12 volts provided on a GFCI circuit
 5. Lens
 - a. Shall be capable of producing a wide or narrow beam by rotating the lens
 6. Gasket
 - a. Single-piece molded U-shape silicone
 7. Cord
 - a. Minimum 35 feet (10.7m) of #16-3ST submersible cord for standard 12VAC line
 - b. Cord entrance shall be epoxy encapsulated
 - c. Contractor shall determine the required cord length prior to ordering the fixture
 - d. Sufficient cord must be coiled in the niche to allow for the removal of the fixture to above water level for maintenance
 8. Factory Leak Tested
 - a. All fixture shall be tested at 10 PSI (0.7 kPa) internal pressure while total submerged in water
 9. Low Water Cut-Off
 - a. Temperature sensing circuit to reduce power to LEDs to prevent damage
- C. Color Changing LED Fixtures
 1. Acceptable Manufacturers

- a. Crystal Fountains – LED Series
 - b. Pentair – Intellibrite 5G Color LED
 - c. Hydrel – Model 4426 LED RGB Color Changing
2. Niche
 - a. Stainless Steel, Cast Bronze, or High Strength PVC with provisions for positive locking of fixture in position
 - b. Minimum of four tie locations to form work or steel structural rods
 - c. Pressure grounding lug on interior and exterior surfaces
 - d. Conduit entrance shall be 3/4" (20mm) NPT with 3/4" x 1/2" (20mm x 12mm) NPT reducer bushing supplied
 - e. Niche shall be appropriately sized to the fixture
3. LED Type
 - a. System shall be composed of two components
 - i. RGB LED Array Board
 - ii. Driver
 - b. Lamp life shall be rated at a minimum 50,000 hours
 - c. LED light shall be capable of producing a 100 to 300 Watt incandescent equivalency
4. Voltage shall be 12 volts provided on a GFCI circuit
5. Control
 - a. Standard DMX512.3
 - i. 3-Channel per Fixture: Red, Green, Blue
 - ii. 4-Channel per Fixture: Red, Green, Blue, Intensity
 - b. Communication shall be DMX512.3 direct
 - i. Provide secondary conduit for DMX control lines
 - c. Compatible Proprietary Controller
 - i. Waterproof outdoor rated enclosure
 - ii. Color Changing Options
 - iii. Preprogrammed light changing routines
6. Lens
 - a. Shall be capable of producing a wide or narrow beam by rotating the lens
7. Gasket
 - a. Single-piece molded U-shape silicone
8. Cord
 - a. Minimum 35 feet (10.7m) of #16-3ST submersible cord for standard 12VAC line
 - b. Cord entrance shall be epoxy encapsulated
 - c. Contractor shall determine the required cord length prior to ordering the fixture
 - d. Sufficient cord must be coiled in the niche to allow for the removal of the fixture to above water level for maintenance
9. Factory Leak Tested
 - a. All fixture shall be tested at 10 PSI (0.7 kPa) internal pressure while total submerged in water
10. Low Water Cut-Off

- a. Temperature sensing circuit to reduce power to LEDs to prevent damage
 - D. Alternative Fixture Mounts
 1. Acceptable Manufacturers
 - a. Crystal Fountains
 - b. Hydrel
 - c. Delta Fountains
 - d. PEM Fountains
 2. Contractor shall use mounts provided by the fixture manufacturer
 3. Stand Mounts
 - a. Contractor shall verify stand dimensions with the intended application
 - b. Stand shall be capable of securely anchoring the fixture
 4. Slab Mounts
 - a. Shall be used in conjunction with a false floor system
 - b. Fixture shall be anchored securely with a "foot friendly" mounting ring
- 2.2 HANDRAILS
 - A. Approved Manufacturers and Suppliers
 1. Spectrum Aquatics
 2. Lincoln
 3. Recreonics
 4. Custom Fabrication
 - B. Handrails shall be constructed of 316L stainless steel. Stair handrails shall extend at least 32 inches (800mm) above the pool deck and any other local code requirements
 - C. All bends shall be wrinkle free
 - D. Handrail anchors shall be H. D. bronze with bronze wedge and stainless steel bolt. Anchor shall be cast in concrete deck, stairs, and/or pool shell
 - E. Handrails and accessories must be approved by the architect prior to ordering
 - F. Handrails shall be grounded according to the latest NEC requirements
- 2.3 LADDERS
 - A. Approved Manufacturers and Suppliers
 1. Spectrum Aquatics
 2. Lincoln
 3. Recreonics
 4. Custom Fabrication
 - B. Grab rails shall be constructed of 316L stainless steel. Stair handrails shall extend at least 28 inches (700mm) above the pool deck and any other local code requirements.
 - C. Provide number of rungs necessary for the depth of pool in location shown on Construction Documents. Rungs shall be constructed of HDPE with molded nut inserts
 - D. Grab rail anchors shall be H. D. bronze with bronze wedge and stainless steel bolt. Anchor shall be cast in concrete deck, stairs, and/or pool shell
 - E. Grab rails, recess treads, and accessories must be approved by the architect prior to ordering
 - F. Grab rails shall be grounded according to the latest NEC requirements

2.4 PORTABLE VACUUM SYSTEMS

- A. Approved Manufacturer's
 - 1. Recreonics, Maxi Sweep II
 - 2. Lincoln
 - 3. Spectrum Aquatics
- B. Portable Vacuum System shall be fully self contained, portable with a wheeled cart, and shall include one self-priming pump with hair and lint strainer, one filter housing, 50 feet (15m) of vacuum hose, minimum 100 feet (30.5m) of electrical power cord, pool vacuum head, and telescoping pole with 20 foot (6m) minimum reach
- C. Provide two (2) spare filter cartridges for each filter for each vacuum system

2.5 POOL ACCESS LIFT

- A. Approved Manufacturers and Suppliers
 - 1. S. R. Smith
 - 2. Spectrum Aquatics
 - 3. Global Lift Corporation
 - 4. Recreonics
 - 5. Lincoln
- B. Pool lift shall be compliant with all aspects of the 2012 ADA Standards for Accessible Design, Sections 242 and 1009
- C. The Contractor shall provide the appropriate number of pool lifts to comply with the 2010 ADA Standards for Accessible Designs.
- D. The Contractor shall provide a installation drawing from the pool lift manufacturer showing the as-built edge condition and the interaction of the specified pool lift
- E. The Contractor shall follow all manufacturer recommendations for installation of pool lift and associated anchors

2.6 Thermal Pool Covers

- A. Approved Suppliers
 - 1. Spectrum Aquatics
 - 2. T-Star Enterprises – EnergySaver XER
 - 3. Approved Equal
- B. Contractor shall submit manufacturer's shop drawing showing layout of cover segments as needed and required heat loss calculation
- C. Material shall be woven 10 x 14 count per inch, high density polyethylene (HDPE) ultraviolet stabilized film, permanently laminated to both sides of 1/8 inch (3mm) thick, closed cell, medium density, white polyethylene foam.
- D. The cover polyethylene film shall be coated on the side not laminated to the foam with at least 3 mils UV inhibitor, blue in color.
- E. The layers making up the finished blanket shall be non-toxic, non-absorbent, non-permeable, and buoyant
- F. Edging material shall be PVC coated Tarpaulin, 100% stabilized polyester woven 20 x 20 count 1000D, coated and UV stabilized on both sides. The weighting for the edging shall be extruded black vinyl. The edging system shall have drain holes punched every three (3) feet (1m)
- G. The pool cover shall meet or exceed the following criteria:

1. Thickness: 1/8 inch (3mm) +/- 10% of total thickness
2. Foam Density: 2 lbs/ft³ +/- 10% (ASTM D1910)
3. Tensile Strength: 260 lbs (118 kg) warp x 330 lbs (150 kg) weft (ASTM D751, grab)
4. Weight: 0.08 lbs/ft² (1/8 inch blanket without edging)
5. Tear Strength: 80 lbs (36 kg) warp x 84 lbs (38 kg) weft (ASTM D751, tounge)
6. Bursting Strength: 640 lbs (290 kg) (ASTM D751, Mullen)
7. UV Weathering: 90% Retained Strength 2,000 hours exposure (ASTM G154)
8. Service Temperature: -40 °F / 180 °F (-40 °C / 82 °C)
9. K Factor: 0.25 BTU in/hr·ft²·F
10. Grommet Tear Strength: 1,928 lbf (8.58 kN) (minimum) Tension per Section

H. Loop Tie Assembly

1. The Assembly shall consist of two (2) components: a plasticized, non-slip, UV inhibited HDPE loop tie handle, and a 12 strand 5/16 inch (8mm) synthetic rope joined to the loop tie handle with two (2) flame sealed knots.
2. Rope shall have the following properties:
 - a. High strength to weight ratio
 - b. High resistance to abrasion
 - c. Tensile strength of 9,000 lbf (40 kN)
 - d. High resistance to chemicals and pH imbalance
 - e. Specific gravity of 0.95
 - f. Heat resistance (melting point 384 °F (196 °C))

I. Grommets shall be 305 Stainless Steel passivated to ASTM A967

J. Threading Material shall be non-wicking, ultra-bonded polyester thread, with UV protection. The single-end strength shall be approximately 21.2 lbs (9.6 kg) with a melting point between 480-500 °F (249-260 °C)

K. Pool Cover shall carry a warranty of a minimum of four (4) years

L. Contractor shall provide the appropriate number of storage reels. Reels shall be movable with the option for fixed installation as shown in the Contract Documents.

2.7 LANE DIVIDERS, ANCHORS, AND SAFETY LINES

A. Approved Suppliers

1. Recreonics
2. Lincoln
3. Spectrum Aquatics

B. Provide anti-wave lane dividers, safety lines, and anchors as shown in the Contract Documents

2.8 Starting Platforms

A. Approved Suppliers

1. Spectrum Aquatics
2. Lincoln
3. Recreonics

B. Starting platform shall be the rear mount type, with either single or double post design, allowing for ease of removal. Anchor assemblies shall be supplied with a cover for use when starting platform is removed.

C. The platform shall be designed and tested to not deflect when burdened with a 350 lbs (160 kg) dynamic load.

- D. Color and graphic selections shall be confirmed with the architect, prior to ordering
 - E. Starting platform shall consist of the following components
 - 1. Platform Frame
 - a. Fabricated of 2.5 inch (62mm) O.D. x 1/4 inch (6mm) wall thickness, 300 series stainless steel and is to be formed in one continuous length, no welded mitered joints will be allowed
 - b. Shall be designed to support a starting surface at 30 inches (762mm) from water level
 - c. A backstroke bar shall be 300 series stainless steel and shall be 18 inches (457mm) wide and will be located 14.75 inches (375mm) from the water surface
 - d. Access step attachment bracket shall be 300 series stainless steel.
 - e. All welds associated with the fabrication process are to be fusion TIG type
 - 2. Platform Top
 - a. High density polyethylene (HDPE) top shall be 23 inches (584mm) by 25 inches (635mm) and shall have a non-slip textured surface
 - b. The platform shall slope toward the pool edge at a 10-degree angle with the front edge 29.5 inches (749mm) from water surface
 - 3. Step
 - a. Shall be an 8 inch (203mm) by 10 inch (254mm) molded HDPE with a non-slip textured surface
 - 4. Anchor
 - a. Single Anchor – 3.5 inch (89mm) O.D. x 2.5 inch (63mm) bronze anchor sleeve shall support the starting platform assembly. The anchor shall have a 2.5 inch (63mm) diameter locating slot in its top surface. The locating slots are to receive the rotation retention rod of the starting platform.
 - b. Double Anchor – two (2) 2.06 inch (52mm) O.D. x 1.9 inch (48mm) I.D., 300 series stainless steel anchor sleeves shall support the starting platform assembly. The sleeves shall be mounted to a 12-gauge, 300 series stainless steel channel, 20 inches (508mm) on center. The top of the sleeve shall be reinforced with a 3/8 inch (10mm) stainless steel rod.
 - c. The anchor shall be fitted with a grounding bolt for proper bonding.
 - d. A tamper resistant lid(s) and lid removal tool shall be provided.
 - 5. Numbering
 - a. Lane numbers shall be applied so that they are visible from all four (4) sides of the platform. The number shall be dark blue in color and shall be chemical and UV resistant vinyl.
 - F. Warranty
 - 1. Platform shall be supplied with a minimum two (2) year limited warranty
- 2.9 MAINTENANCE KIT
- A. Acceptable Suppliers
 - 1. Recreonics
 - 2. Lincoln
 - B. Provide one (1) maintenance kit for each swimming pool over 200 sq. feet (18.5 sq. m) of surface area, with a minimum of one (1) kit per pool area.
 - C. Each kit shall include the following:

1. Three (3) 8 foot (2.5m) sections of 1.25 inch (32mm) diameter heavy duty stainless steel handles
2. One (1) 24 inch (0.6m) heavy duty nylon bristle wall brush
3. One (1) 18 inch (0.45m) algae brush
4. One (1) nylon bristle corner brush
5. One (1) heavy duty leaf skimmer
6. One (1) heavy duty leaf rake

2.10 SAFETY KIT

- A. Acceptable Suppliers
 1. Recreonics
 2. Lincoln
- B. Provide one (1) safety kit for each swimming pool over 200 sq. feet (18.5 sq. m) of surface area, with a minimum of one (1) kit per pool area.
- C. Each kit shall include one (1) of each of the following items for pools under 50 feet (15m) in both directions and two (2) if any direction is over 50 feet (15m)
 1. 20 inch (0.5m) Ring Buoy, U. S. Coast Guard approved, PFD Type IV with integral rope and holder
 2. 18 foot (5.5m) heavy duty yellow aluminum pole with shepherd's hook

2.11 SAFETY SIGNAGE

- A. Approved Suppliers
 1. Recreonics
 2. Lincoln
 3. Custom Fabricator
- B. Signage shall be coordinated with the architect and facility operator for layout and format of each sign
- C. Signage shall comply with local code requirements as to size of lettering and content
- D. The following are minimum recommendations:
 1. POOL RULES: Provide one (1) sign for each pool listing the following rules, coordinate with owner and architect for additional rules for each pool:
 - a. All persons using the Pool do so at their own risk. Owner and Management are responsible for accidents or injuries.
 - b. No Food or Beverages may be served on the Pool wet deck
 - c. No Animals allowed in the Pool or on the Pool Deck
 - d. No Running or Rough Play in Pool Area
 2. NO LIFE GUARD ON DUTY: Provide a minimum of one (1) warning sign indicating there is No Life Guard On Duty
 3. POOL CAPACITY: Provide one (1) sign for each pool stating the maximum number of people allowed in each pool
 4. POOL HOURS: Provide one (1) sign for each fenced pool area stating the hours of operation for the Pool.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install products, equipment, and accessories in accordance with manufacturer's recommendations, local building codes, and Public Health Department requirements

- B. Locate Underwater Light Fixtures, Handrails, Ladders, and Accessories in locations shown in the Contract Documents

3.2 UNDERWATER LIGHT FIXTURES

- A. Install Light Fixtures a minimum of 18 inches (450mm) below water level, unless fixture is specifically designed for shallower water
- B. All metal niches shall be positively grounded according to NEC requirements
- C. All conduit shall be water tight
- D. All floor mounted fixtures shall have "foot friendly" mounting rings to prevent foot entrapment or injury
- E. The Contractor shall provide the necessary junction boxes, potting compound, low voltage transformers, and LED control systems required for complete operation of the lights

3.3 HANDRAILS AND LADDERS

- A. Install Handrails and Ladders in locations shown on the Contract Documents and in compliance with local code requirements
- B. Contractor shall verify that all elements are properly grounded in accordance with NEC and local codes.

3.4 PORTABLE VACUUM SYSTEMS

- A. Contractor shall provide at a minimum one (1) portable vacuum system per pool area at the close of the project

3.5 POOL ACCESSIBLE LIFTS

- A. Contractor shall provide the appropriate number of pool lifts to comply with the 2010 ADA Standards for Accessible Design

3.6 THERMAL POOL COVERS

- A. Contractor shall install the pool covers in accordance with manufacturer recommendations.
- B. Contractor shall verify that the pool covers accommodates vertical elements in the pool such as, handrails, ladders, etc.

3.7 STARTING PLATFORMS

- A. Contractor shall install anchors as per manufacturer recommendations and as shown in the Contract Documents.
- B. Contractor shall verify with the architect and owner on color and graphic selections.
- C. Contractor shall verify that all elements are properly grounded in accordance with NEC and local codes.

3.8 POOL SIGNAGE

- A. Contractor shall locate Pool Signage as shown on the Contract Documents.
- B. When Signage is not shown on the Contract Documents, the Contractor shall refer to the architect or landscape architect for placement

END OF SECTION

SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS

PART 1 - GENERAL**1.1 SUMMARY****A. This section includes the following:**

1. Furnishing and installing PVC pipe and tubing
2. Furnishing and installing PVC pipe joints and fittings
3. Furnishing and installing HDPE pipe and tubing
4. Furnishing and installing HDPE pipe joints and fittings
5. Furnishing and installing Above Grade Copper Pipe and Fittings
6. Furnishing and installing flexible HDPE pipe supports
7. Furnishing and installing anchoring structures for HDPE pipe

B. Related Sections:

1. SECTION 13 1106 – WATER FEATURE TRENCHING
2. SECTION 13 1107 – WATER FEATURE BACKFILLING
3. SECTION 13 1402 – WATER FEATURE PIPE TESTING AND CLEANING
4. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
5. SECTION 13 1404 – WATER FEATURE WHITE GOODS
6. SECTION 13 1501 – WATER FEATURE MECHANICAL IDENTIFICATION
7. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
8. SECTION 13 1503 – WATER FEATURE FILTERS
9. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
10. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
11. SECTION 13 1507 – WATER FEATURE HEATERS
12. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS

C. References:

1. ASME B16.18 – CAST COPPER ALLOY SOLDER JOINTS
2. ASTM B88 – STANDARD SPECIFICATION FOR SEAMLESS COPPER WATER TUBING
3. ASTM D1248 – STANDARD SPECIFICATION FOR POLYETHYLENE MOLDING AND EXTRUSION MATERIALS
4. ASTM D1785 – STANDARD SPECIFICATION FOR POLY(VINYL CHLORIDE) (PVC) PLASTIC PIPE, SCHEDULES 40, 80 AND 120
5. ASTM D2464 – STANDARD SPECIFICATION FOR THREADED POLY(VINYL CHLORIDE) (PVC) PLASTIC PIPE FITTINGS, SCHEDULE 80
6. ASTM D2466 – STANDARD SPECIFICATION FOR POLY(VINYL CHLORIDE) (PVC) PLASTIC PIPE FITTINGS, SCHEDULE 40
7. ASTM D2467 – STANDARD SPECIFICATION FOR SOCKET-TYPE POLY(VINYL CHLORIDE) (PVC) PLASTIC PIPE FITTINGS, SCHEDULE 80
8. ASTM D2564 – STANDARD SPECIFICATION SOLVENT CEMENT FOR POLY(VINYL CHLORIDE) PVC PIPE AND FITTINGS
9. ASTM D2657 – STANDARD PRACTICE FOR HEAT FUSION JOINING OF POLYOLEFIN PIPE AND FITTINGS
10. ASTM D2683 – STANDARD SPECIFICATION SOCKET-TYPE POLYETHYLENE FITTINGS FOR OUTSIDE DIAMETER-CONTROLLED POLYETHYLENE PIPE AND TUBING
11. ASTM D2774 – STANDARD PRACTICE FOR UNDERGROUND INSTALLATION OF THERMOPLASTIC PRESSURE PIPING
12. ASTM D2837 – STANDARD TESTING METHOD FOR OBTAINING HYDROSTATIC DESIGN BASIS FOR THERMOPLASTIC PIPE MATERIALS
13. ASTM D2855 – STANDARD PRACTICE FOR MAKING SOLVENT-CEMENTED JOINTS WITH POLY(VINYL CHLORIDE) (PVC) PIPE AND FITTINGS

14. ASTM D3035 – STANDARD SPECIFICATION FOR POLYETHYLENE (PE) PLASTIC PIPE (DR-PR) BASED ON CONTROLLED OUTSIDE DIAMETER
15. ASTM D3261 – STANDARD SPECIFICATION FOR BUTT FUSION POLYETHYLENE (PE) PLASTIC FITTINGS OR POLYETHYLENE (PE) PLASTIC PIPE AND TUBING
16. ASTM D3350 – STANDARD SPECIFICATION FOR POLYETHYLENE PLASTICS PIPE AND FITTINGS MATERIALS
17. ASTM F412 – STANDARD TERMINOLOGY RELATING TO PLASTIC PIPING SYSTEMS
18. ASTM F905 – STANDARD PRACTICE FOR QUALIFICATION OF POLYETHYLENE SADDLE-FUSION JOINTS
19. ASTM F1056 – STANDARD SPECIFICATION FOR SOCKET FUSION TOOLS FOR USE IN SOCKET FUSION JOINTING POLYETHYLENE PIPE OR TUBING AND FITTINGS
20. AWWA C207 – STEEL PIPE FLANGES FOR WATERWORKS SERVICE – SIZES 4 INCH THROUGH 144 INCHES
21. AWWA C508 – AWWA STANDARDS FOR SWING-CHECK VALVE FOR WATERWORKS SERVICE 2 INCHES THROUGH 24 INCHES NPS
22. AWWA C509 – AWWA STANDARD FOR RESILIENT SEATED GATE VALVES FOR WATER AND SEWER WORKS
23. AWWA C901 – STANDARD FOR POLYETHYLENE (PE) PRESSURE PIPE AND TUBING, ½ INCH THROUGH 3 INCH, FOR WATER SERVICE
24. AWWA C906 – STANDARD FOR POLYETHYLENE (PE) PRESSURE PIPE AND FITTINGS, 4 INCH THROUGH 63 INCH
25. PPI TR-4 – HYDROSTATIC DESIGN BASES, PRESSURE DESIGN BASES, AND MINIMUM REQUIRED STRENGTH RATINGS FOR THERMOPLASTIC PIPING MATERIALS OR PIPE

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit manufacturer's literature including printed recommendations, compliance with Standards and Testing agencies, dimensions and sizes for all piping material, and fittings.
 1. Indicate on submittal which materials, models, data, ratings, and options are being selected
- C. Project Record Documents: The Contractor shall record actual horizontal and vertical locations of pipes, fittings, valves, and accessories for all site piping.
 1. As-built information shall be given to the owner
 2. Information format shall be specified by the owner.

1.3 MATERIALS HANDLING

- A. Upon receiving of shipments, the Contractor shall check to ensure that the correct products and quantities have been delivered. The receiver shall have a procedure for reconciling any shipping discrepancies
- B. Shipment shall be inspected for cuts, abrasions, scrapes, gouges, tears, and punctures
- C. Unloading of shipments shall be done in accordance with manufacturer's recommendations
- D. Pipes shall not be rolled or pushed off the delivery truck
- E. All fabricated parts or fittings shall not be pushed or dumped off or dropped off the delivery truck
- F. Wire rope slings and chains shall not be permitted to move pipe or fittings
- G. Small diameter pipe shall not be stored inside of larger diameter pipe
- H. Storage facility shall be clear of debris
- I. Stacking and storage of pipe and fitting shall conform to manufacturer's recommendations

- J. Non-UV protected components shall not remain in unprotected outdoor storage for more than two (2) years
- K. Pipe shipped by trucking shall have the first third of the load covered with tarpaulins to ensure against diesel smoke contamination

PART 2 - PRODUCTS**2.1 POLYVINYL CHLORIDE (PVC) PIPING**

- A. Approved Manufacturers and Suppliers
 - 1. Harvel Plastics
 - 2. JM Eagle
 - 3. Pacific Plastics Incorporated
 - 4. North American Pipe Corporation
 - 5. Approved Equal
- B. Buried Unplasticized Polyvinyl Chloride (uPVC) Pressure Pipe:
 - 1. To comply with ASTM D1785, Schedule 40
 - 2. If buried depth of pipe exceeds manufacturers recommended loading, Schedule 80 Pipe will be used
 - 3. Schedule 80 pipe will be used for all sleeves
- C. Above Grade Unplasticized Polyvinyl Chloride (uPVC) Pressure Pipe:
 - 1. To comply with ASTM D1785, Schedule 80
 - 2. Light gray in color
- D. Screwed and Socketed PVC Pipe:
 - 1. To comply with ASTM D2464

2.2 POLYVINYL CHLORIDE (PVC) FITTINGS AND JOINTS

- A. Approved Manufacturers and Suppliers
 - 1. Spears Manufacturing
 - 2. LASCO Fittings
 - 3. JM Eagle
 - 4. Naco Industries
 - 5. Approved Equal
- B. Buried Unplasticized Polyvinyl Chloride (uPVC) Fittings:
 - 1. To comply with ASTM D2466 or ASTM D2467
 - 2. Flanged or solvent weld. No "slip type" or "push on type" gasket joints will be permitted
 - 3. Gasket Material for flanged couplings to be composed of Viton®, EPDM, or Teflon® (PTFE)
 - 4. Solvent Cement to comply with ASTM D2564
- C. Above Grade Unplasticized Polyvinyl Chloride (uPVC) Fittings:
 - 1. To comply with ASTM D2467
 - 2. Flanged or solvent weld. No "slip type" or "push on type" gasket joints will be permitted
 - 3. Gasket Material for flanged couplings to be composed of Viton®, EPDM, or Teflon® (PTFE)
 - 4. Solvent Cement to comply with ASTM D2564
 - 5. All PVC pipe exposed to sunlight shall be coated to resist deterioration due to ultraviolet radiation
 - 6. Color to match above grade piping, light gray
- D. Screwed and Socketed PVC Fittings:

1. To comply with ASTM D2464
- E. Flanges:
1. Dimensions and drilling to comply with ANSI Standards
 2. Rated as 250 lbs (113.5 kg) flanges
 3. Gasket Material for flanged couplings to be composed of Viton®, EPDM, or Teflon® (PTFE)
 4. Back-up rings, bolts, washers, nuts, and threaded studs shall be 316L Stainless Steel
- 2.3 HIGH DENSITY POLYETHYLENE (HDPE) PIPE
- A. Approved Manufacturers and Suppliers
1. ISCO Industries
 2. JM Eagle
 3. US Plastic Corporation
 4. Approved Equal
- B. Polyethylene Tubing
1. To comply with ASTM D1248
 2. Tubing to be black in color
- C. Buried HDPE Pressure Pipe:
1. To comply with ASTM D2774
 2. Pressure Rating of 130 psi (896 kPa) – Schedule DR 13.5
 3. If buried depth of pipe exceeds manufacturer's recommended loading a higher pressure rated pipe shall be used
 4. Schedule DR7.3 pipe shall be used for all sleeves
- D. Above Grade HDPE Pressure Pipe:
1. To comply with ASTM D2774
 2. Pressure Rating of 200 psi (1,379 kPa) – Schedule DR 9.0
 3. Black in color with 2-3% carbon black in the material
- E. Polyethylene Tubing
1. To comply with ASTM D1248
 2. Tubing to be black in color
- 2.4 HIGH DENSITY POLYETHYLENE (HDPE) FITTINGS
- A. Acceptable Manufacturers and Suppliers
1. Plexco
 2. Rincor
 3. ISCO Industries
 4. US Plastic Corporation
 5. Approved Equal
- B. Buried HDPE Fittings:
1. To comply with ASTM 3261
 2. Flanged or Butt Fused
 3. Gasket Material for flanged couplings to be composed of Viton®, EPDM, or Teflon® (PTFE)
- 2.5 COPPER PIPE AND FITTING
- A. Approved Manufacturers and Suppliers
1. Mueller Industries
 2. NIBCO

- B. Above Grade Copper Pipe
 - 1. To comply with ASTM B88
 - 2. Type L, Hard Drawn
 - 3. Solder: ASTM B32, Grade 95TA
- C. Above Grade Copper Fittings:
 - 1. To comply with ASME B16.18 or ASME B16.22

PART 3 - EXECUTION**3.1 GENERAL**

- A. All pipe installation shall be in strict accordance with the instruction and recommendations provided by the pipe manufacturer
- B. Size of any section of pipe for which size is not indicated or any intermediate section erroneously shown undersized shall be the same size as the largest pipe connecting to it.
- C. Pipe sizes shown on the Contract Documents are nominal
- D. Design Velocities in pipe shall not exceed 5.5 feet per second (1.7 m/s)
- E. All Pipe used to transport water that will come in contact with the general population shall be NSF 50 Approved for potable water use
- F. Pipe shall have a print line every 2 feet (0.6m) stating the manufacturer, product, trade name, material, size, and dimension ratio, manufacturing standard, production lot code, and date of manufacturing
- G. Fitting shall be individually marked with the following information: description, material, manufacturing standard, and production lot number

3.2 PREPARATION

- A. Hot dip galvanize all items that are not factory furnished or 316L Stainless Steel
- B. Determine depth, size, and alignment of existing utilities before beginning excavation
- C. Use only tools and components required to construct and installed joints in accordance with the manufacturer's recommendations
- D. All field connection methods and procedures required that the component ends to be free of surface defects before the connection is made
- E. Heat Fusion of HDPE Pipe Preparation
 - 1. During inclement weather a temporary shelter shall be set up over the joining operation to shield operations from rain, frozen precipitation, and cold winds
 - 2. Entirely review the specific procedures outlined by manufacturer for performing heat fusion joints

3.3 PVC PIPE INSTALLATION

- A. Below Grade Piping (Site Piping)
 - 1. Obtain written approval from governing Municipality prior to connecting to main lines. Connect to main lines where indicated on the Contract Documents and as approved by governing Municipality
 - 2. Verify dimensions and elevations of main lines are as indicated on the Contract Documents. Immediately notify Owner/Engineer of any discrepancies or conflicts
 - 3. Make connections to main lines and visually inspect for leakage with line under pressure prior to backfilling

4. Install pipe to indicated elevation to within tolerance of 5/8 (15mm). Avoid installing pipe with high and low points. Install air/vacuum valves at all high points
 5. Exercise due care to avoid deposit of excavation material and other foreign substance in interior of pipe. Remove foreign material from pipe before proceeding with the Work. Plug pipe during work stoppages to prevent debris from entering pipes
 6. Place a minimum of 4 inch (0.1m) deep bed of approved bedding material
 7. Where two or more pipes are placed side by side in the same trench maintain clear spacing between pipes to allow for hand operated mechanical compaction equipment or 12 inches (0.3m) whichever is greater
 8. Joint deflection greater than two (2) degrees will not be allowed
 9. PVC pipe saddles shall be secured to the pipe with two (2) 316L Stainless Steel pipe clamps and both saddle and straps shall be wrapped in a fiberglass liner
 10. Where pipes extend under footings run pipe in Schedule 80 pipe sleeves. Sleeves shall be next larger pipe size and extend 10 feet (3m) beyond front and back face of footing
 11. Repair broken small diameter pipes with glued couplings, large diameter pipes with flexible repair couplings
 12. Install liner boots and provide water tight joints between liner and liner boot at all pipe penetrations
 13. Install link seal through all wall penetrations that have dry conditions on both sides of the wall
 14. Install water stop flanges at all wall penetration that have wet conditions on either side of the wall
 15. Welded (glued) buried pipe does not require thrust blocks, except at locations shown on the Contract Documents and immediately after flexible couplings.
- B. Above Grade Piping
1. Locate equipment in location shown on the Contract Documents. Position or rotate equipment to result in good appearance and easy access to all components for maintenance and repairs prior to installing piping
 2. Install, level, and secure equipment. Provide shims, anchors, support straps, angles, grouted bases or other items as required to accomplish proper installation
 3. Install flanges on pipe larger than 3 inches (80mm) where ever connections are made to pumps, valves, strainers, and other equipment to facilitate removal for servicing. For pipes smaller than 3 inches (80mm) use union connections
 4. Install piping, flues, breaching ducts, and supports so they do not interfere with equipment access
 5. Change pipe size within three pipe diameters of final connection to pumps, filters, and other equipment where it is necessary to reduce pipe size
 6. Cut pipe accurately to job measurements within plus or minus ¼ inch (6mm) and install without springing or forcing, true to line and grade, generally square with building and structures
 7. Adequately support pipe, fittings, and accessories to prevent undue stress and to comply with SECTION 13 1403.
 8. Arrange pipe and hangers to allow for expansion, contraction, and structural settlement
 9. Make changes of direction with manufactured fittings
 10. Street elbows, bushings, reducing flanges, close nipples, or bending pipe will not be allowed
 11. Pipe shall not contact structure except at penetrations shown on the Contract Documents
 12. Run pipe full size through shutoff valves, balance valves, and control valves unless otherwise noted on the Contract Documents
 13. Seal pipes penetrating and existing wall through core drilled holes with "Link Seal" type expansion seals
 14. Seal pipes penetrating new walls under construction through a PVC sleeve with water stop flange and a Link Seal placed between pipe and approved sleeve
 15. Provide dielectric connections between copper and dissimilar metals Install connections in vertical sections of piping only

16. The Contractor shall coordinate pipe routing with electrical duct banks and heating/ventilation duct work
 17. All pipes that are installed above grade and outdoors shall have a heavy coat of light color latex base paint that is chemically compatible with PVC pipe and fittings. Compatibility should be confirmed by paint manufacturer
- C. Joints and Solvent Welds
1. Install above grade, below grade, buried, and imbedded PVC piping using solvent weld fittings in accordance with ASTM D2564, ASTM 2774, and ASTM D2855
 2. Remove any burrs and chamfer pipe ends after cutting then prepare each fitting and pipe end with solvent primer
 3. Join each fitting individually and allow enough time for the joint to seal solidly before assembly of adjacent joints
 4. After joining, and even ring of primer shall be visible around entire fitting
 5. If fittings are installed without visible primer, fitting shall be removed and discarded and piping re-cut, re-chambered, and joint made up again using a new fitting
- 3.4 HDPE PIPE INSTALLATION
- A. Below Grade Piping (Site Piping)
1. Obtain written approval from governing Municipality prior to connecting to main lines. Connect to main lines where indicated on the Contract Documents and as approved by governing Municipality
 2. Verify dimensions and elevations of main lines are as indicated on the Contract Documents. Immediately notify Owner/Engineer of any discrepancies or conflicts
 3. Make connections to main lines and visually inspect for leakage with line under pressure prior to backfilling
 4. Install pipe to indicated elevation to within tolerance of 5/8 (15mm). Avoid installing pipe with high and low points. Install air/vacuum valves at all high points
 5. Exercise due care to avoid deposit of excavation material and other foreign substance in interior of pipe. Remove foreign material from pipe before proceeding with the Work. Plug pipe during work stoppages to prevent debris from entering pipes
 6. Place a minimum of 4 inch (0.1m) deep bed of approved bedding material
 7. Where two or more pipes are placed side by side in the same trench maintain clear spacing between pipes to allow for hand operated mechanical compaction equipment or 12 inches (0.3m) whichever is greater
 8. Pipes shall not be dumped, dropped, pushed, or rolled into the trench
 9. Wire rope slings and chains shall not be permitted to lower pipe or fittings into trench
 10. Cold or "Field" bending of pipe shall only be done in accordance with the manufacturer's recommendations for the pipe diameter and dimension ratio
 11. Large diameter fabricated fittings (16 inch (400mm) and larger) shall not be joined to more than one pipe before placement in the trench
 12. Where pipe extend under footings, run pipe in DR 7.3 pipe sleeves. Sleeves shall be next larger pipe size whose inside diameter will accommodate the outside diameter of the pipe being sleeved. Sleeves shall extend 10 feet (3m) beyond front and back face of footing.
 13. Install liner boots and provide water tight joints between liner and liner boot at all pipe penetrations
 14. Install link seal through all wall penetrations that have dry conditions on both sides of the wall
 15. Install water stop flanges at all wall penetrations that have wet conditions on either side of the wall
 16. Buried HDPE Pipe require thrust blocks at locations shown on the Contract Documents and directly after flexible couplings

17. Fitting breakage due to unusual stresses during installation shall be replaced at the Contractor's expense
 18. HDPE pipe that enters or exits a structure shall be wrapped in an elastomeric material, and then the annulus between the pipe and the casing shall be sealed with an appropriate sized link seal
 19. HDPE pipe that is flanged before entering a structure shall require a structural support to prevent shear and bending loads as shown on the Contract Documents. The pipe shall be protected from chaffing by wrapping with an elastomeric sheet
 20. HDPE pipe or fittings that are jointed to valves, hydrants, or other heavy device shall require a support pad as shown on the Contract Documents
 21. Locating wire shall be 12 AWG (2mm) copper wire placed in the trench above the pipe but not touching the HDPE pipe
 22. Stabilizing Agents that generate temperature in excess of 200 °F (93 °C) shall not be used in conjunction with HDPE pipe
- B. Above Grade Piping
1. Locate equipment in location shown on the Contract Documents. Position or rotate equipment to result in good appearance and easy access to all components for maintenance and repairs prior to installing piping
 2. Install, level, and secure equipment. Provide shims, anchors, support straps, angles, grouted bases or other items as required to accomplish proper installation
 3. Install flanges on pipe larger than 3 inches (80mm) where ever connections are made to pumps, valves, strainers, and other equipment to facilitate removal for servicing. For pipes smaller than 3 inches (80mm) use union connections
 4. Install piping, flues, breaching ducts, and supports so they do not interfere with equipment access
 5. Change pipe size within three pipe diameters of final connection to pumps, filters, and other equipment where it is necessary to reduce pipe size
 6. Cut pipe accurately to job measurements within plus or minus ¼ inch (6mm) and install without springing or forcing, true to line and grade, generally square with building and structures
 7. Adequately support pipe, fittings, and accessories to prevent undue stress and to comply with SECTION 13 1403.
 8. Arrange pipe and hangers to allow for expansion, contraction, and structural settlement
 9. Make changes of direction with manufactured fittings
 10. Pipe shall not contact structure except at penetrations shown on the Contract Documents
 11. Run pipe full size through shutoff valves, balance valves, and control valves unless otherwise noted on the Contract Documents
 12. Seal pipes penetrating and existing wall through core drilled holes with "Link Seal" type expansion seals
 13. Seal pipes penetrating new walls under construction through a PVC sleeve with water stop flange and a Link Seal placed between pipe and approved sleeve
 14. Provide dielectric connections between copper and dissimilar metals Install connections in vertical sections of piping only
 15. The Contractor shall coordinate pipe routing with electrical duct banks and heating/ventilation duct work
- C. Joining and Connections
1. Connection design limitations and manufacturer's joining procedures shall be observed throughout construction
 2. All field connection methods and procedures require that the component ends shall be clean, dry, and free of detrimental surface defects before the connection is made
 3. Cleaning: General dust and light soil shall be removed with clean, dry, lint free cloths. Heavier soil may be washed off with mild soap and water followed by a through rinsing with clean water and drying with a dry, clean, lint free cloth. Chemical cleaning solvents shall not be used

4. Cutting: HDPE pipe shall be cut with approved equipment and methods to ensure square-cut ends
 - a. Small diameter pipe (4 inches (100mm) and smaller) shall be cut with guillotine shears, run-around cutters, or small manual saws
 - b. Large diameter pipe shall be cut with handsaws and chainsaws. Chainsaws shall be operated without chain lubrication
 - c. Chips from saws shall be removed from pipe bore
 - d. De-burr pipe ends
 - e. Branch outlet holes shall be cut with hole saws specified by the pipe manufacturer to ensure adequate chip clearance, saw depth, and an inside relief to retain the couplings
 - f. Hole saws shall be withdrawn frequently to clear chips
 - g. Power hole saws shall be operated at low speeds to avoid overheating and melting pipe material
5. Heat Fusion Joining:
 - a. Open flame shall not be used for heating pipe ends
 - b. HDPE products that have permeated with hydrocarbons shall not be heat fused
 - c. Faulty Fusions:
 - i. Socket or butt fusions shall be removed and redone
 - ii. Heat Fusion joints cannot be repaired and shall be removed
 - iii. Socket and saddle fusion fittings cannot be reused
 - d. Socket fused pipe or tubing shall be manufactured to Outside Diameter controlled pipe or tubing specifications
 - e. Saddle fusion processes shall be applied to pipe sizes and pressure ratings as dictated by the pipe manufacturer, and only with approved equipment to perform sizes required
 - f. Molded butt fusion fittings and fabricated fittings are acceptable for use
 - g. When installing Polyethylene (PE) pipe in a butt fusion machine, do not bend the pipe against and open fusion machine collets or clamp
 - h. Bead removal of butt fusion is not required. If bead removal is necessary the pump must be cooled to ambient temperature and the bead shall only be removed down to the pipe's surface
 - i. Electro-fusion shall be used to repair damaged sections of pipe or tie-in joints in the trench
6. Flanged Connections
 - a. All flange connections shall have back-up flanges
 - b. Back-up flanges shall be 316L Stainless Steel
 - c. One edge of back-up ring bore shall be chamfered. This edge fits against the back of the sealing flange
 - d. Back-up rings shall be fitted to flange adapter before fusion to pipe
 - e. Gasket Material for flanged couplings to be composed of Viton®, EPDM, or Teflon® (PTFE)
 - f. Gasket material shall be between 1/8 – 3/16 inch (3.2 – 4.8mm) thick
 - g. Stub end flanges are not permitted
 - h. Full face gaskets shall be used on larger pipes (greater than 12 inch (0.3m)). Drop-in gasket shall be used on smaller pipe sizes
 - i. Back-up ring dimensions and drilling shall comply with ANSI standards
 - j. Bolting materials shall be of 316L Stainless Steel. Flange bolts are 1/8 inch (3mm) smaller than the bolt hole diameters on the back-up ring. Flat washers of 316L stainless steel shall be used between the nut and the back-up ring.
 - k. Full face HDPE flanges without back-up rings are not acceptable
 - l. Mating flanges shall be aligned together before tightening
 - m. Flange connections shall be properly supported to avoid bending stresses

- i. Below grade flanges shall require a support foundation of compacted, stable, granular fill, or compacted cement stabilized granular backfill, or reinforced concrete
 - ii. Flanged connections adjacent to pipes passing through structural walls must be structurally supported to avoid shear loads as indicated on the Contract Documents
 - iii. Above grade flanges shall be supported on rigid structures that are designed to withstand flexing due to thermal changes and ensure that the flange does not become anchored in soil
 - n. Prior to fit-up, lubricate flange bolt threads, washers, and nuts, with non-fluid lubricant
 - o. Gasket and flange sealing surfaces must be clean and free of significant cuts or gouges
 - p. Fit flange components together loosely. Tighten bolts by hand and re-check alignment. Adjust alignment as necessary.
 - q. Tighten bolts in sequence determined by manufacturer to 5 ft-lbs (6.8 N-m) torque to establish a sealing surface
 - r. Once the sealing surface has been established, continue tightening bolts in the recommended sequence in 15 ft-lbs (20 N-m) torque or less. Tighten completely through the sequence before changing to higher torque
 - s. Do not exceed maximum recommended bolt tightening torque values as established by the manufacturer
 - t. Once recommended torque values are reached wait at least one (1) hour and retighten bolts for final value the first time. Retighten bolts in same sequence as outlined before
 - u. Do not exceed 15 ft-lbs (20 N-m) torque in any sequence
 - v. When connecting HDPE Pipe to cast iron tighten torque increments should not exceed 10 ft-lbs (13 N-m)
 - w. When connecting flanges to butterfly valves, the Installer shall use tubular spacers to ensure that the valve disc clears the inside diameter of the HDPE pipe. Bolt lengths shall be increased to meet spacer requirements
7. Mechanical Joints
 - a. Only fully restrained joints shall be approved for use on pressure lines
 - b. Fully restrained joints shall include insert stiffeners and exterior mechanical coupling. Materials of mechanical joints shall be approved by the Design Engineer before installation
 - c. Partially restrained joints and unrestrained joints are only appropriate on non-pressure pipe systems and must be approved for use by the Design Engineer before installation
8. Other Joining Techniques
 - a. Pipe Treads: Pipe threads shall not be used to join HDPE pipe
 - b. Extrusion Welding shall not be used on pressure pipe systems
 - c. Hot Gas Welding shall not be used to join HDPE pipe
9. Branch Connections
 - a. Tees in main line sizes larger than 16 inches (0.4m) shall be flanged on two of the three connections
 - b. Mechanical saddles or branch fittings that clamp around the main and seal with gaskets shall not be installed without the specific consent of the Design Engineer
 - c. Service Saddles shall be secured with wide band straps, and double band straps designs. U-bolt type service saddles shall not be accepted
- D. Flexible Supports and Expansion Loops
 1. Above Grade Supports
 - a. HDPE pipe supports shall accommodate thermal expansion and contraction, limit vertical deflection and comply with manufacturer's guidelines for size and pressure rating of pipe

- b. Support for HDPE pipe shall cradle at least 120 degrees of the pipe and be at least $\frac{1}{2}$ pipe diameter wide
 - c. Edges of cradle shall be rounded or rolled to prevent cutting into pipe
 - d. Use of U-bolt, narrow strap-type hanger, and roller type supports are unacceptable
 - e. Long term deflection of pipe between hangers shall not exceed 1 inch (25mm)
 - f. Use of pipe racks for support shall be of sufficient width to accommodate expansion and contraction of pipe
 - g. Centered anchored pipe shall be allowed to pivot at the anchor point
 - h. Expansion joints are not recommended
 - i. An initial deflection shall be provided so HDPE pipe does not contract to a straight line
 - j. Fittings shall be protected from flexing due to expansion or contraction of piping system
 - k. Fittings and flanges shall be supported on sleepers to ensure that fittings will not become anchored in soil
 - 2. Below Grade Pipe Supports
 - a. HDPE pipe shall be placed in trench by “snaking” pipe in the trench to allow for expansion and contraction
 - b. Expected temperature changes in buried pipe shall be addressed with thrust blocks as suggested by the manufacturer
 - c. When HDPE pipe is connected to bell and spigot joined pressure systems, the two bell and spigot joints closest to the connection shall be restrained
 - 3. Anchoring Structures
 - a. All HDPE pipe installed underwater or below the ground water line shall be checked for the need of anchoring by the Contractor.
 - b. Ballast Design for HDPE pipe shall conform to manufacturer’s recommendations and include the following:
 - i. Submergence weights shall be made of reinforced concrete and formed in two or more sections that clamp around the pipe leaving a clearance between the sections
 - ii. An elastomeric padding material shall be used between the submergence weights and the pipe
 - iii. Submergence weights shall be sized such that bottom sections are generally 50% heavier than the top sections.
 - iv. All fasteners that connect the submergence weights shall be rated for marine use
- 3.5 INSPECTION AND TESTING – FOR HDPE PIPE
- A. Please refer to SECTION 13 1402 – WATER FEATURE PIPE TESTING AND CLEANING
 - B. Butt Fusion Joint Quality
 - 1. Visually inspect all butt fusion joints of both pipe and fitting connections
 - a. The double bead width should be approximately 2 to 2.5 times the height from the pipe surface
 - b. Both beads should be uniform in size and shape all around the joint
 - c. The depth of the V-Groove between the two beads shall not be more than half of the bead height
 - 2. Destructive Testing
 - a. The first butt fusion of an individual fusion machine shall be destructively tested each day
 - b. A bent strap specimen is prepared by making a trial butt fusion and allowing it to cool to ambient temperature
 - c. The test strap shall be at least 6 inches (0.15m) of 15 pipe wall thickness long on each side of the fusion joint

- d. The test strap shall be at least 1 inch (25mm) or 1.5 pipe wall thickness wide
 - e. Bend the strap until ends of the test strap touch. Any disbondment at the fusion joint is unacceptable and indicates that the fusion procedure and/or machine set-up needs to be changed
 - f. Field fusion shall not proceed until a test joint has passed the bent strap test
 - g. Precautions shall be taken to ensure that personnel safety is maintained while performing the bent strap test
3. Surface Damage
- a. Butt fusion misalignment shall not exceed 10% the minimum wall thickness for a given pipe size
 - b. Surface gouges shall not exceed 10% of the minimum wall thickness for a given pipe size
 - c. Deep, sharp notches shall be dressed smooth to reduce chance of crack propagations
 - d. Minor abrasions from sliding pipe shall not be of a concern

END OF SECTION

SECTION 13 1402 – WATER FEATURE PIPE TESTING AND CLEANING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Testing and Cleaning of the piping system
- B. Related Sections:
 - 1. SECTION 13 1106 – WATER FEATURE TRENCHING
 - 2. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
 - 3. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Prior to installing pipe, provide a plan to remove foreign materials from pipes that may have gained access into newly installed or repaired main lines
- C. Certification: Provide certification that the piping system to be tested has been thoroughly cleaned and meets or exceeds specified requirements prior to testing pipeline
- D. Test Reports: Provide results of every test passing or failing. The Contractor and Owner's Representative shall sign each Test Report. Reports shall include a description of the pipeline being tested, date, start time, pressure at the start of the test, pressure as the second part of the test, ending time, and pressure at the end of the test. If any additional water was added to the pipeline during the test, the quantity and times must be noted. Any other comments specific to the test shall also be noted

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

3.1 GENERAL

- A. All newly laid and installed piping shall be subjected to a Hydrostatic Pressure Test
- B. Prior to test verify all piping, valves, and fittings have been laid and properly installed. Verify bolts on all flanges are tight and secure
- C. Test each pipeline within five (5) days after completion of the pipeline section. Each section of pipeline must successfully pass the Pressure Test and have been thoroughly flushed prior to submittal of payment
- D. The Hydrostatic Pressure Test shall not be done in conjunction with a line disinfection process
- E. A Leakage Test shall be conducted in connection with the Pressure Test, if and only if directed by the Engineer
- F. The Contractor shall furnish all the necessary equipment and manpower for completing the Hydrostatic Pressure Test and Leakage Test
- G. The Contractor shall provide sufficient flanges, plugs, or caps so that a pipe that has successfully passed the Tests can and shall remain under pressure for the duration of the construction period or until start-up
- H. Keep all personnel a safe distance away from test points during testing
- I. The test section shall be supervised at all times during the test
- J. All piping shall be restrained against possible movement from catastrophic failure at joints and connections. Never conduct Test on unrestrained piping

- K. All joints of test sections shall be properly cured and/or cooled before testing can begin
 - L. Mechanical connections must be completely installed and tightened per manufacturer's instructions
 - M. If backfill provided restraint, backfill shall be properly placed and compacted. Joints and connections must be exposed for inspection
 - N. End closures must be suitable for pressure service and pressure-rated for the test pressure
 - O. Fill out appropriate worksheet indicating information of section tested. Samples of worksheets are found immediately following this specification
- 3.2 HYDROSTATIC PRESSURE TESTS FOR PVC PIPE AND FITTINGS
- A. Test the pipeline at 1.5 times the maximum static pressure anticipated in the pipeline, or at 70 psi (482 kPa), whichever is greater
 - B. Prior to testing, the pipeline shall be flushed or vacuumed to remove all construction debris and foreign material from the pipeline
 - C. Perform the Hydrostatic Pressure Test using the following procedure:
 - 1. Install flanges on both ends of the pipeline and at any tees or branches in the line as required
 - 2. Install a test pressure gauge at the lowest end of the pipeline. The full scale reading of the test gauge shall not be more than 15% of the specified test pressure. For a test pressure of 70 psi (482 kPa) the maximum gauge reading would be 80 psi (551 kPa)
 - 3. Slowly fill the pipeline with clean water
 - 4. Expel any air from the pipeline, make necessary taps at points for highest elevation before test made and insert plugs after the test has been completed
 - 5. Bring pipe to specified test pressure plus 10 psi (69 kPa), by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pressure on the gauge must be corrected to account for the elevation for which the gauge is installed
 - 6. Maintain the specified test pressure plus 10 psi (69 kPa) for one (1) hour by adding additional water as required.
 - 7. At the end of the hour, reduce the pressure in the line by 10 psi (69 kPa) to the specified test pressure
 - 8. Immediately after the pressure has been reduced to the specified test pressure begin Part 2 of the test. Part 2 of the test shall last for two (2) hours
 - 9. A successful test shall consist of maintaining the specified test pressure for the entire two (2) hour duration without a drop in pressure on the test pressure gauge
 - 10. During the test period, neither additional water nor air is to be added to the pipeline, unless a Leakage Test had been requested by the Engineer, and only if requested
 - D. After the Hydrostatic Pressure Test has been completed the line shall be flushed as described in t Section 3.3
- 3.3 LEAKAGE TEST FOR PVC PIPE AND FITTINGS ONLY
- A. The Leakage Test shall serve as a secondary acceptance test and is to be used solely at the discretion of the Engineer and if the Hydrostatic Pressure Test failed
 - B. The Test shall be performed in the same manner as the Hydrostatic Pressure Test described in Section 3.2. However, once the two (2) hour time period described in Section 3.2.C.8 is started, water shall be added to the system as required to maintain the specified test pressure for the entire two (2) hour duration
 - C. The amount of leakage is defined as the quantity of water added to the pipeline to maintain the specified test pressure for the entire two (2) hours

- D. No pipe installation will be accepted until the leakage test is less than 10 gallons per mile (38 liters per 1,609m), per 2 inch (50mm) diameter, per day

3.4 HYDROSTATIC PRESSURE TEST FOR HDPE PIPE AND FITTINGS

A. Test Section:

1. Test section length is to be determined by the capacity of the testing equipment. Testing equipment must be able to fill and pressurize the test section in two (2) hours or less
2. Before applying test pressure, allow time for the water in the test section to equalize to a common temperature
3. Measure temperature of the test section once water and pipe have reached a common temperature

B. Test Pressure

1. Install flanges on both ends of the pipeline and at any tees or branches in the line as required
2. Install a test pressure gauge at the lowest end of the pipeline. The full scale reading of the test gauge shall not be more than 15% of the specified test pressure. For a test pressure of 70 psi (482 kPa) the maximum gauge reading would be 80 psi (551 kPa)
3. The base test pressure is 70 psi (482 kPa). Test pressure may be reduced when the test section is at elevated temperatures as follows:
 - a. Temperature $\leq 80^{\circ}\text{F}$ (27°C): Multiplier = 1.00
 - b. Temperature $\leq 90^{\circ}\text{F}$ (32°C): Multiplier = 0.90
 - c. Temperature $\leq 100^{\circ}\text{F}$ (38°C): Multiplier = 0.80
 - d. Temperature $\leq 110^{\circ}\text{F}$ (43°C): Multiplier = 0.75
 - e. Temperature $\leq 120^{\circ}\text{F}$ (49°C): Multiplier = 0.65
 - f. Temperature $\leq 130^{\circ}\text{F}$ (55°C): Multiplier = 0.60
 - g. Temperature $\leq 140^{\circ}\text{F}$ (60°C): Multiplier = 0.50

C. Test Duration

1. The maximum test duration is eight (8) hours including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize the test section.
2. If the test is not completed due to leakage, equipment failure, or for any other reason, depressurize the test section completely, and allow it to relax for at least eight (8) hours before pressurizing the test section again

D. Test Procedure:

1. Fill restrained test section completely with clean water. Allow time for water and pipe to come to a common temperature
2. Determine section testing pressure: 70 psi (482 kPa) * Temperature Multiplier (Section 3.4.B.3)
3. Ensure that no air is trapped in the test section
4. Gradually pressurize the test section to section testing pressure and maintain test pressure for three (3) hours. During this expansion phase add water as needed to maintain section test pressure
5. After the three (3) hour expansion period, measure and record the amount of make-up water required to maintain section test pressure for two (2) hours
6. Failure of the test is determined by the amount of water required to maintain section test pressure. Make-up water shall not exceed the following quantities per 100 feet (30.5m)

Nominal Pipe Size		Make-up Water	
(inches)	(mm)	(gallons)	(liters)
1-1/4	32	0.10	0.38
1-1/2	40	0.10	0.38
2	50	0.11	0.42
3	80	0.15	0.57
4	100	0.25	0.97
5	125	0.38	1.44
5-3/8	137	0.41	1.55
6	150	0.60	2.27
7-1/8	180	0.70	2.64
8	200	1.00	3.78
10	250	1.30	4.92
12	300	2.30	8.70
13-3/8	340	2.50	9.50
14	350	2.80	10.60
16	400	3.30	12.50
18	450	4.30	16.3
20	500	5.50	20.80
22	550	7.00	26.5
24	600	8.90	33.70
26	650	10.00	37.80
28	700	11.10	42.00
30	750	12.70	48.00
32	800	14.30	54.00
34	850	16.20	61.00
36	900	18.00	68.00

7. At the conclusion of the test, carefully depressurized the test section by the controlled release of the test water

3.5 FLUSHING PIPELINES FOR PVC AND HDPE PIPE

- A. All pipelines shall be thoroughly flushed or vacuumed before and immediately after the Pressure Test.
- B. If the line is damaged after the initial Pressure Test, the lines shall be thoroughly flushed or vacuumed and the Pressure Test repeated
- C. Flushing will only remove the lighter solids and cannot be relied upon to remove heavy material or debris that was allowed to enter the main during installation

- D. Extreme care and thorough inspection shall be practiced during installation of pipelines to prevent small stones, pieces of concrete, particles of metal, sand, dirt, or other foreign material from gaining access into the pipelines
- E. Once the line has been thoroughly flushed, flanges, plugs, and/or caps shall be installed on the pipeline. The pipe shall be filled with water and shall remain full for the duration of construction or until start-up

3.6 QUALITY ASSURANCE

- A. Should any test of pipe fail to maintain pressure or exceed the allowable leakage for the entire two (2) hour duration, the Contractor, at his own expense, shall locate and repair or replace defective pipe, fittings, or connections and then re-test the pipe again until test results are within the specified allowances
- B. The Engineer or Owner may direct the Contractor to repair specific leaks regardless of the test results, if leaks are found in the pipeline

END OF SECTION

(Pertains to Section 13 1402.3.2)

Date: _____

PVC PIPE PRESSURE TEST For: _____

SITE CONDITIONS:

Ambient Air Temperature: _____ °F or °C (circle one)

Description of section being tested: _____

Nominal Pipe Diameter: _____ inches or mm (circle one)

Pipe Length: _____ Feet or Meters (circle one)

Testing Media: _____ (Water or Other, please specify)

Maximum Pressure Reading: _____ psi or kPa (circle one)

TESTING DATA:

Section Testing Pressure: _____ psi or kPa (circle one)

Initial time of brining section to test pressure + 10 psi (69 kPa): _____ a.m. or p.m.

Time when pressure test began: _____ a.m. or p.m.

Time when pressure test ended: _____ a.m. or p.m.

Pressure at end of test: _____ psi or kPa (circle one)

Test Passed? _____ Yes or _____ No

(Contractor's Signature)

(Owner's Representative's Signature)

(Pertains to Section 13 1402.3.4)

Date: _____

HDPE PIPE PRESSURE TEST For: _____SITE CONDITIONS:

Ambient Air Temperature: _____ °F or °C (circle one)

Testing Section Temperature: _____ °F or °C (circle one) Temperature Multiplier: _____

Description of section being tested: _____

Nominal Pipe Diameter: _____ inches or mm (circle one)

Pipe Length: _____ Feet or Meters (circle one)

Testing Media: _____ (Water or Other, please specify)

TESTING DATA:

Section Testing Pressure (Testing Pressure * Temperature Multiplier): _____ psi or kPa

Time Test Section filling began: _____ a.m. or p.m.

Time when Section Test Pressure is achieved: _____ a.m. or p.m.

Time when pressure test began: _____ a.m. or p.m.

Time when pressure test ended: _____ a.m. or p.m.

Amount of water added during Pressure Test: _____ gallons or liters (circle one)

Test Passed? _____ Yes or _____ No

(Contractor's Signature)_____
(Owner's Representative's Signature)

SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Pipe and Equipment Hangers and Supports
 - 2. Equipment Pads and Supports
 - 3. Sleeves, Seals, and Waterstop Flanges
 - 4. Thrust Blocks
 - 5. Flexible Couplings
- B. Related Sections:
 - 1. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 2. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
 - 3. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 4. SECTION 13 1503 – WATER FEATURE FILTERS
 - 5. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 6. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
 - 7. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
 - 8. SECTION 13 1507 – WATER FEATURE HEATERS
 - 9. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
 - 10. SECTION 13 1509 – WATER FEATURE CHILLERS
 - 11. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
 - 12. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
- C. References:
 - 1. ASME B31.2 – FUEL GAS PIPING
 - 2. ASME B31.9 – BUILDING SERVICES PIPING
 - 3. ASTM A536 – STANDARD SPECIFICATION FOR DUCTILE IRON CASTING
 - 4. ASTM F708 – STANDARD PRACTICE FOR DESIGN AND INSTALLATION OF RIGID PIPE HANGERS
 - 5. MMS SP58 – PIPE HANGERS AND SUPPORTS – MATERIALS, DESIGN AND MANUFACTURER
 - 6. MMS SP69 – PIPE HANGERS AND SUPPORTS – SELECTION AND APPLICATION

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Provide manufacturers catalog data including type of material and load capacity.
- C. Shop Drawings: the Contractor shall provide drawings indicating hanger schedule and layout showing location, type, and material of hanger, sign and sealed by a Structural Engineer
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe and riser support hangers
- E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components
- F. Warranty: Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer.

PART 2 - PRODUCTS**2.1 PIPE HANGERS AND SUPPORTS**

- A. Acceptable Manufacturers
 - 1. Grinnell
 - 2. B-Line

- B. Pipe Hangers:
 - 1. Conform to ASME B31.9 and ASTM F708
 - 2. All Hangers shall be fiberglass or stainless steel. Galvanized is acceptable only for installations in non-marine or non-coastal environments subject to approval by the Engineer
 - 3. Hangers for pipe sizes ½ inch to 1-1/2 inch (15mm to 40mm): adjustable swivel, split ring style
 - 4. Hangers for pipe sizes 2 inch (50mm) and larger: adjustable, clevis style
 - 5. Multiple or Trapeze Hangers: fiberglass channels with spacers and hanger rods. Galvanized material is acceptable for non-marine or non-coastal environments subject to approval by the Engineer
 - 6. Hangers shall be sized to support the pipe when full of water
- C. Hanger Rods:
 - 1. Use rod threaded at both ends or continuously threaded. Stainless steel rod for marine environments. For non-marine or non-coastal environments galvanized steel is acceptable, subject to approval by the Engineer
 - 2. Sized adequately to support pipes full of water
- D. Fasteners:
 - 1. Shall be fiberglass or stainless steel. Galvanized is acceptable only for non-marine or non-coastal environments, subject to approval by the Engineer

2.2 WALL SLEEVES and SEALS

- A. Acceptable Manufacturers
 - 1. Linkseal
 - 2. Thunderline Corporation
 - 3. Innerlynx
- B. Sleeves: Molded, non-metallic high density polyethylene
- C. Fasteners: 316L Stainless Steel
- D. Pressure Plates: Molded glass reinforced nylon
- E. Elastomers: EPDM

2.3 WATERSTOP FLANGES

- A. Acceptable Manufacturers
 - 1. ASA Manufacturing Incorporated
 - 2. Lawson Aquatics
 - 3. Approved Custom Fabrication
- B. PVC Waterstop Sleeve Fittings
 - 1. Shall be constructed of PVC and be capable of being primed and glued in place
 - 2. Waterstop shall be place between the water-retaining side of the wall and the reinforcing steel
 - 3. Waterstop shall be tied in place to the reinforcing steel
- C. Fiberglass Waterstop Sleeve Fittings
 - 1. Shall be constructed of fiberglass and be capable of accepting Schedule 40 and Schedule 80 PVC pipe with socket to socket connections

2.4 FLEXIBLE COUPLINGS

- A. Acceptable Manufacturers
 - 1. Cascade Waterworks

2. Baker Flex Couplings
3. Dresser Couplings
- B. Ductile Iron end and center rings complying with ASTM A536
- C. EPDM or Viton® gaskets
- D. Fasteners shall be 316L Stainless Steel, including nuts, bolts, and washers
- E. Coupling shall be designed for below ground installation

PART 3 - EXECUTION**3.1 Installation**

- A. General:
 1. Acceptable pipe supports are shown in the General Details section of the Contract Documents
 2. Support Valves and Equipment adequately at both flanges, if in a horizontal position, and by the top flange if in a vertical position
- B. Pipe Hangers and Supports
 1. Support horizontal and vertical piping as scheduled
 2. Install hangers to provide a minimum ½ inch (13mm) space between finished covering and adjacent work
 3. Place hangers within 12 inches (0.3m) of each horizontal elbow.
 4. Use hangers with 1-1/2 inch (38mm) minimum vertical adjustment
 5. Support horizontal pipe with a 5 feet (1.5m) maximum spacing between hangers, or as determined by Structural Engineer
 6. Provide lateral restraints at bends in pipe as required and as directed by the Structural Engineer
 7. Support vertical piping at every floor the pipe passes through. Provide intermediate supports where spacing exceeds 10 feet (3m) between supports
 8. Support for vertical piping shall include both vertical and lateral support
 9. Install couplings or similar tight fitting metal sleeve at each floor support for vertical piping. Couplings or sleeves shall rest on and transmit load to support
 10. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers
 11. Provide copper plated hangers and supports for copper piping
 12. Design hangers for pipe movement without disengagement of supported pipe
 13. Size Hanger Rods, screws, bolts, nuts, etc according to manufacturer's sizing charts for mass and pipe size being supported
 14. Do not use wire or other makeshift devices for hangers
 15. Pipe located near the floor may be supported with galvanized steel stanchions welded to end plates and secured to pipe and floor
 16. To prevent sway and lateral movement due to thrust, provide angle iron bracing anchored into walls or overhead framing at bends. In seismic zones, use appropriate sway suppression devices
- C. Equipment Pads and Supports
 1. Provide Equipment, or Housekeeping, Pads of concrete, minimum of 4 inches (0.1m) thick and extending a minimum of 3 inches (75mm) beyond supported equipment, unless otherwise noted on the Contract Documents
 2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment
 3. Provide shims, anchors, support straps, angles, grouted bases, or other items required to accomplish proper installation
 4. Construction of galvanized steel stanchions welded to end plates secured to the floor and pipe or equipment

D. Sleeves, Seals, and Water Stop Flanges

1. Set Sleeves in position in form work. Provide adequate reinforcing around sleeves
2. Size Sleeves large enough to allow for movement due to expansion and contraction
3. Extend Sleeves through floors 1 inch (25mm) above finished floor level. Chalk Sleeves
4. Install "Link Seal" type waterproof seal at all penetrations to floors, ceilings, or walls that do not penetrate into water retaining structures
5. Install water stop flanges with a bead of Swell Seal around pipe at the base of the flange for all penetrations into water retaining structures
6. Waterstop shall be place between the water-retaining side of the wall and the reinforcing steel
7. Provide a minimum 2 inch (50mm) cover of concrete for all Waterstop Flange couplings.
8. Waterstop shall be tied in place to the reinforcing steel

E. Thrust Blocks

1. Install concrete anchor blocks, thrust blocks, and support blocks with tie downs to support pipe, fittings, or valves as indicated on the drawings
2. For buried piping install concrete thrust blocks at the first bend after mechanical fasteners, or after a pipe penetrates a wall.
3. Thrust blocks may not be required for glued or welded pipe, subject to approval by the Engineer

F. Flexible Couplings

1. Install Flexible Couplings in areas of anticipated differential settlement including, but not limited to:
 - a. Building wall penetrations
 - b. Retaining and site wall penetrations
2. Install two (2) couplings per pipeline with a minimum of 2 feet (0.6m) spacing between couplings
3. Support couplings to prevent pipe pullout
4. Provide concrete thrust block at first bend after flexible couplings
5. When couplings are used to repair broken pipes, install concrete thrust blocks upstream and downstream from the coupling

END OF SECTION

SECTION 13 1404 – WATER FEATURE WHITE GOODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Prefabricated Skimmers
 - 2. Prefabricated Bottom Drains
 - 3. Prefabricated Gutter
 - 4. Gutter Drains
 - 5. Perimeter Grating
 - 6. Large Drain Sump Grating
 - 7. FRP Balance Tanks
 - 8. Floor and Wall Inlet Jets
 - 9. Hydrotherapy Jets
 - 10. Hydrostatic Relief Valves
- B. Related Sections:
 - 1. SECTION 13 1204 – WATER FEATURE CAST IN PLACE CONCRETE
 - 2. SECTION 13 1205 – WATER FEATURE SHOTCRETE
 - 3. SECTION 13 1301 – WATER FEATURE PLASTER FINISHES
 - 4. SECTION 13 1302 – WATER FEATURE TILE FINISHES
 - 5. SECTION 13 1305 – WATER FEATURE ACCESSORIES
 - 6. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
 - 7. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 8. SECTION 13 1503 – WATER FEATURE FILTERS
 - 9. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
- C. References:
 - 1. National Sanitation Foundation (NSF) – Standard 50 Specification
 - 2. NFPA 70 – National Electrical Code (NEC) – Article 680-21
 - 3. Underwriters Laboratories (UL)
 - 4. Virginia Graeme Baker Pool and Spa Safety Act (VGB)

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURE.
- B. Product Data: Submit manufacturer's literature including printed recommendations, compliance with Standards and Testing Agencies, dimensions and sizes of products.
 - 1. Indicated on submittal which materials, models, data, ratings, and options are being selected
- C. Shop Drawings: Indicated layout, general assembly, components, dimensions, clearances, and method of assembly
- D. Maintenance Data: Include manufacturer's literature, maintenance recommendation, and replacement parts list

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Accept components on site in factory packing and inspect for damage
- B. Protect components received at site from physical damage, including effects of weather, water, and construction

PART 2 - PRODUCTS

2.1 PREFABRICATED SKIMMERS

- A. Approved Manufacturers and Suppliers
 - 1. Pentair Pool Products
 - 2. Hayward Industries
 - 3. Waterway Plastics
 - 4. Recreonics
 - 5. Lincoln
- B. Prefabricated Skimmers shall be NSF 50 approved
- C. Skimmer body shall be constructed of molded non-corrosive material such as ABS, PVC, or HDPE and designed to be cast into concrete with a minimum of 4 inches (0.1m) concrete covering the basket housing
- D. A floating removable weir that automatically adjusts to variations in the water level shall be provided and installed in the skimmer
- E. An equalizer valve assembly shall be installed in the wall of the pool or into the bottom drain and piped to the skimmer as noted on the Contract Documents
 - 1. All equalizer pipes shall have a VGB Compliant cover when installed in the wall of the pool
- F. A removable debris basket shall be provided. Basket shall be constructed of a non-corrosive material such as nylon or stainless steel and shall be access by removal of a cover plate
- G. Provide an adjustable deck collar with cover plate. Cover plate shall be heavy duty, non-corrosive, and of a non-slip design. The cover plate shall be secured to the collar and skimmer body with stainless steel locking screws or clips. The Contractor shall provide extension collars as required.

2.2 PREFABRICATED BOTTOM DRAINS

- A. Approved Manufacturers and Suppliers
 - 1. Pentair Pool Products
 - 2. Hayward Industries
 - 3. ASA Manufacturing, Incorporated
 - 4. Lawson Aquatics
 - 5. Recreonics
 - 6. Lincoln
- B. Prefabricated Drains shall be certified as compliant to VGB requirements and applicable NSF 50 Standards
- C. Prefabricated Drains shall be constructed of non-corrosive and non-conductive materials, such as fiberglass, PVC, or HDPE and suitable for continuous exposure to chlorinated water environments. Materials shall be UV stabilized. The interior finish shall be smooth and finish color to match the color of the bottom of the pool.
- D. Each prefabricated drain shall have pipe side outlets (FIP) as specified on the Contract Documents. In addition, 2 inch (50mm) bottom outlets (FIP) shall be provided for the placement of hydrostatic relief valves. The Contractor shall verify all pipe connection sizes as shown on the Contract Documents.
- E. Bottom Drain Grates shall be certified as compliant to VGB requirements. Each grate shall be constructed of non-corrosive and non-conductive materials, such as FRP or PVC and shall have a minimum open area of 50%. Grate color shall match the finish of the bottom of the pool or as specified by the architect/landscape architect.
- F. Grates shall be fastened to the frame with 316L stainless steel fasteners. Removal of grate fastener shall require the use of a tool.

2.3 PREFABRICATED GUTTER

- A. Approved Manufacturers and Suppliers
 - 1. ASA Manufacturing
 - 2. Lawson Aquatics
- B. Prefabricated Gutters shall be constructed of multiple layers of premium fiberglass and resin. Interior of gutters shall have a smooth gel coat finish. A water stop flange shall be integral to the gutter construction
- C. Individual fiberglass sections to be available in either straight or curved sections in lengths up to 10 feet (3m) and are to be flanged, pre-drilled, and include the necessary stainless steel hardware for bolting the sections together
- D. Gutter outlets shall be sized as shown on the Contract Documents. The Contractor shall verify all pipe connection sizes
- E. Gutter shall be installed as per manufacturer's recommendations for leveling and assembly. All gutters shall be level within 0.125 inches (3mm) along the entire perimeter
- F. The Contractor shall provide Perimeter Grating that is compatible with the gutter system

2.4 GUTTER DRAINS

- A. Approved Manufacturers and Suppliers
 - 1. Pentair Pool Products
 - 2. Hayward Industries
 - 3. Recreonics
 - 4. Lincoln
- B. Gutter Drain fittings shall be NSF 50 approved
- C. Gutter Drain fittings shall be constructed of a non-corrosive and non-conductive material, such as ABS or PVC.
- D. The Contractor shall provide gutter drain fittings as shown on the Contract Documents and shall verify the pipe connection sizes.

2.5 PERIMETER GRATING

- A. Approved Manufacturers and Suppliers
 - 1. Lawson Aquatics
 - 2. RenoSys
 - 3. Natare
 - 4. Recreonics
 - 5. Lincoln
- B. Perimeter grating shall be constructed of UV stabilized PVC, FRP, or other non-corrosive and non-conductive material. Stone or precast concrete grating shall be non-porous.
- C. The top surface must have a raised, non-slip pattern to meet the static coefficient of friction when wet or dry
- D. The space between the pieces must not exceed 0.375 inches (10mm) and provide a minimum open area of 37.5% per foot to allow unrestricted water flow.
- E. The grate color shall be as specified by the architect/landscape architect.
- F. The Contractor shall verify the thickness of the grate is compatible with the construction of the gutter

2.6 Large Drain Sump Grating

- A. Approved Manufacturers and Suppliers
 - 1. Seasafe Grating
 - 2. Grating Systems Incorporated
 - B. Large Drain Sump Grating shall be custom fabricated from molded ore pultruded FRP or PVC, of sufficient strength to support a live load of 40 lbs/sq. foot (366 kg/sq. m), maximum deflection of L/360, maximum clearance space of 0.375 inches (10mm), and a minimum clear open area of 50%. The grate color shall be as determined by the architect/landscape architect
 - C. Custom fabricated grating shall meet the requirements of the VGB and shall be provided with the appropriate identification of compliance
 - D. The Contractor shall provide all recommended support structure as determined by the manufacturer
 - E. The grating shall be fastened to the frame with 316L stainless steel screws or clips. All fasteners shall require the use of a tool to remove
- 2.7 FRP Balance Tanks
- A. Approved Manufacturers
 - 1. ASA Manufacturing, Incorporated
 - 2. Vakpak, Incorporated
 - 3. Mer-made Filter, Incorporated
 - B. FRP Balance Tanks may also be referred to as surge tanks or collector tanks and used for gravity flow and non-suction aquatic applications
 - C. FRP Balance Tanks shall be constructed of premium fiberglass and resin and structurally self supporting. Interior of the tank shall be a durable, smooth, non-porous gelcoat coating
 - D. All penetrations shall be integrally formed socket to socket Schedule 40 PVC couplings, located as per the Contract Documents. Flanged connections may be used when tanks are installed above grade
 - E. Provide a solid fiberglass hinged cover with locking mechanism and handle for tanks located in landscape areas. For pedestrian areas, provide an aluminum cover. Fiberglass grate covers may be used when the tank is located in back of house areas where debris is not likely to fall into the tank
 - F. The Contractor shall provide all required concrete ballast support for tanks in potential ground water installations
- 2.8 FLOOR AND WALL INLET JETS
- A. Approved Manufacturers and Suppliers
 - 1. Pentair Pool Products
 - 2. Hayward Industries
 - 3. Waterway Plastics
 - 4. Lawson Aquatics
 - 5. Recreonics
 - 6. Lincoln
 - B. Floor Inlets or Returns shall be fully adjustable molded white PVC or Cycolac body with diffuser plate to provide uniform distribution.
 - C. Wall Inlets or Returns shall be non-directional flow PVC or Cycolac wall fittings with internal threads that allow interchangeable eyeball fittings.
 - D. The Contractor shall verify all pipe connection sizes as shown on the Contract Documents
- 2.9 HYDROTHERAPY JETS

- A. Approved Manufacturers and Suppliers
 - 1. Waterway Plastics
 - 2. Recreonics
 - 3. HydroAir
 - B. Body: Molded white PVC hydrotherapy body with internal threads that allow interchangeable fittings. Body style shall provide a venture for air mixing
 - C. Jet Type and Nozzle Sizes shall vary as indicated on the Construction Documents. If information is not provided on the Construction Documents, the Contractor shall provide the following:
 - 1. Internal Jet: 0.375 inch (10mm) diameter orifice
 - 2. Provide 1/3 of hydrotherapy jets with power massage style jet; 1/3 with pulsator style jet; and 1/3 with roto-style jet
 - 3. All but one of the hydrotherapy jets shall be fully adjustable from full open to full close. One of the jets shall be non-adjustable.
 - D. Hydrotherapy jets shall be located at various elevations within plus or minus 2 inches (50mm) of the location shown in the Contract Documents to allow variety of jet position for the bather
 - E. The Contractor shall verify the size and number of hydrotherapy jets with the Contract Documents
- 2.10 HYDROSTATIC RELIEF VALVES
- A. Approved Manufacturers and Suppliers
 - 1. Pentair Pool Products
 - 2. Waterman
 - 3. Recreonics
 - 4. Lincoln
 - B. For Prefabricated Drain boxes provide 1.5 to 2 inch (40-50mm) threaded Cicolac hydrostatic relief valve with a Cicolac collector tube, as shown in the Contract Documents.
 - C. Cast in Place Drain boxes provide a 2 inch (50mm) commercial grade, heavy duty cast bronze body and valve plate, valve seal gasket and brass cover plate with compatible collector tube, as shown in the Contract Documents.
 - D. The Contractor shall provide hydrostatic relief valves as indicated on the Contract Documents and whenever ground water is present. Hydrostatic relief valves shall be located in the bottom drain boxes.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Install products, equipment, and accessories in accordance with manufacturer's recommendations, local building codes, and Public Health Department requirements.
- B. Locate skimmers, inlets, jets, drains, and etc. in locations shown on the Contract Documents

3.2 PREFABRICATED SKIMMERS

- A. Skimmers shall be installed in accordance with the manufacturer's recommendations and in accordance with the Contract Documents
- B. Locate Skimmers in the pool shell as shown in the Contract Documents. Provide a minimum of 4 inches (0.1m) concrete coverage around the body of the skimmer
- C. Skimmers shall be set to the correct elevation, leveled and held in place during application of shotcrete, or concrete for the pool shell. Skimmers that are not level will be removed, replaced and reinstalled at the Contractor's expense

- D. Skimmers shall be flush with the finish of the pool surface and Skimmer access lids shall be flush with the pool deck
- E. The Contractor shall install water stop flanges on the pipes connecting to the Skimmer
- F. The Contractor shall provide a VGB compliant cover for all equalizer lines that are installed in the pool wall

3.3 PREFABRICATED BOTTOM DRAINS

- A. Install drains as shown on the Contract Documents. Provide at a minimum one (1) bottom drain in the deepest areas of the pool
- B. Drain shall be level with the top of the drain and grate edges flush with the finish of the pool surface, or in accordance with the specific grate manufacturer's recommendations. Slope pool surface to drains with a minimum 1:40 slope. Pool floor shall be constructed such that the low points only occur in the location of the bottom drains
- C. The Contractor shall provide proper reinforcing steel and concrete cover as per the Contract Documents
- D. The Contractor shall install water stop flanges on the pipes connecting to the bottom drains

3.4 PREFABRICATED GUTTER SYSTEM

- A. Install gutter system as per manufacturer's recommendations, including leveling and support devices.

3.5 GUTTER DRAINS

- A. Install gutter drains as shown on the Contract Documents. The Contractor shall verify the spacing of the gutter drains
- B. The Contractor shall slope the gutter to the gutter drains.

3.6 PERIMETER GRATING

- A. Install Perimeter Gutter as shown on the Contract Documents. The Contractor shall install the grating as recommended by the manufacturer
- B. The Contractor shall verify that the grating thickness is compatible with the gutter installation
- C. The grating shall be flush with the pool deck or pool shell as per installation condition

3.7 LARGE DRAIN SUMP GRATING

- A. Install grating as shown on the Contract Documents. Contractor shall obtain manufacturer's fabrication and support drawing and install per manufacturer's recommendations
- B. The grating shall be flush with the pool finish.
- C. The Contractor shall properly anchor grating to frame with 316L stainless steel screws or clips as per manufacturer's recommendations. Fastener shall require the use of a tool to remove.

3.8 FRP Balance Tanks

- A. Install FRP Balance tanks in accordance with the Contract Documents.
- B. The Contractor shall obtain manufacturer's shop drawing showing penetration locations, sizes, and elevations
- C. The Contractor shall provide concrete ballast for tanks installed in locations where ground water may be present
- D. The Contractor shall provide the appropriate cover for the surrounding area, whether in landscape, pedestrian, or back of house spaces

- E. The Contractor shall notify the Engineer of Record if the tank is installed four (4) or more feet below the bottom of the pool, as this may create a potential suction condition
- F. Enclosed FRP balance tanks shall have a vent pipe, of sufficient diameter, that extends above the water surface of the pool. The vent shall be configured to prevent obstruction, whether by manmade means or natural means
- G. The Contractor shall provide necessary float control valves as specified in the Contract Documents or as per Manufacturer recommendation

3.9 FLOOR AND WALL INLET JETS

- A. Install floor and wall jets in accordance with manufacturer's recommendation and as indicated on the Contract Documents.
- B. Install jets in locations as shown on the Contract Documents. Jets shall be installed flush with the finished surface of the pool
- C. The Contractor shall make the necessary adjustments to the floor inlet jets to provide a balance and even distribution throughout the pool

3.10 HYDROTHERAPY JETS

- A. Install hydrotherapy jets in accordance with manufacturer's recommendations and as indicated on the Contract Documents
- B. Install hydrotherapy jets in locations as shown on the Contract Documents. Jets shall be installed flush with the finishes surface of the pool
- C. Install hydrotherapy jets with the air port on the top. The Contractor shall install the air supply line at the highest possible elevation between the pool and the Hartford Loop.
- D. The Contractor shall install a Hartford Loop in a location that has been coordinated with the landscape architect/architect to provide as much concealment as possible. The Hartford Loop shall be located in close proximity of the pool

3.11 HYDROSTATIC RELIEF VALVES

- A. Install hydrostatic relief valves in accordance with the manufacturer's recommendations and as indicated on the Contract Documents.
- B. The Contractor shall prepare an area around the collector tube that provides free draining material and filter fabric between the native material and the free draining material

END OF SECTION

SECTION 13 1501 – WATER FEATURE MECHANICAL IDENTIFICATION

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Equipment Name Plates
 - 2. Valve Tags
 - 3. Stencils
 - 4. Pipe Markers
- B. Related Sections:
 - 1. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
 - 2. SECTION 13 1404 – WATER FEATURE WHITE GOODS
 - 3. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 4. SECTION 13 1503 – WATER FEATURE FILTERS
 - 5. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 6. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
 - 7. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
 - 8. SECTION 13 1507 – WATER FEATURE HEATERS
 - 9. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
 - 10. SECTION 13 1509 – WATER FEATURE CHILLERS
 - 11. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
 - 12. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
 - 13. SECTION 13 1515 – AQUARIUM ACCESSORY EQUIPMENT
- C. References:
 - 1. The latest published edition of a reference shall be applicable, unless identified by a specific edition date.
 - 2. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - a. ANSI / ASME A13.1 “Scheme for the Identification of Piping Systems”
 - b. ANSI Z535.1 “Safety Color Code”

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Submit product data sheets on all products contained in this section for approval. Data sheets must substantiate conformance with applicable standards.
- C. Shop Drawings: Provide drawings indicating wording, symbols, letter size, and color coding for mechanical identification
 - 1. Submit process diagram indicating equipment numbers and valve tag numbers with a valve schedule and chart. Schedule shall indicate valve position during normal and shutdown operation.
 - 2. Approved drawing shall be mounted on foam board, laminated, and mounted on mechanical room wall.

1.3 Coordination

- A. Coordinate installation of mechanical identification devices with the completion of covering and painting of services where devices are to be applied
- B. Coordinate installation of mechanical identification devices with the location of access panels and doors.
- C. Install identifying devices before installing acoustical ceiling tiles or similar concealment.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Provide manufacturers standard products that conform to ANSI / ASME A13.1 requirements for lettering size, background size, background color and angle of installation.
- B. Provide mechanical identification materials manufactured by:
 - 1. Brady Company
 - 2. Allen Systems
 - 3. Seton Corporation
 - 4. Approved Contractor Submitted Alternate

2.2 EQUIPMENT NAME PLATES

- A. General: Provided an engraved multi-layered plastic laminated nameplate for all mechanical equipment purchased for this project. Nameplate to be 1/16" thick black with white letters. Provide an additional engraved nameplate for each disconnect and controller connected to the mechanical equipment.
- B. Mechanical Equipment: Nameplate shall be a minimum of 3" high x 6" wide engraved with 3/4" high (minimum) lettering identifying the Equipment Tag as shown on the mechanical drawings and schedules. If necessary, the size of the plate should be enlarged to accommodate 3/4" characters. Do not reduce the letter height.
- C. Disconnects and Controllers: Nameplate shall be a minimum of 2" high x 4" wide engraved with 1/2" high (minimum) lettering exactly matching the connected equipment nameplate. If necessary, the size of the plate should be enlarged to accommodate 1/2" characters. Do not reduce the letter height.
- D. Access Panels: Provide a 1/16" thick white nameplate with black letters identifying access to concealed valves or equipment such as those found above acoustical ceilings tiles. The nameplate shall be 3/4" high x 2 1/2" wide. Coordinate the information to be engraved on each plate so that it exactly matches the valve tag or equipment nameplate. The minimum letter height shall be 1/4". Install these nameplates on the ceiling support to the right of the tile that would provide access.

2.3 VALVE TAGS

- A. General: Provide valve tags on all controlling valves installed and related to this project. Match service abbreviations and identification number with mechanical drawings.
- B. Valve Tags shall be approximately 19 gauge brass and no less than 1 1/2" in diameter. Tag shall be stamped and black filled with a service abbreviation and ID number. The service abbreviation shall be on the top line and be no less than 1/4" in height. The ID number shall be on the bottom line not less than 1/2" in height. If necessary, to accommodate longer abbreviations or number sequences increase tag size to 2" in diameter.
- C. Attach valve tag to the stem or body of the valve so that the tag is visible but doesn't interfere with the valve operation.

2.4 STENCILS

- A. Description: Stencils with clean cut symbols and letters of the following size:
 - 1. 3/4 to 1-1/4 inch (19 to 32mm) Outside Diameter of Insulation or Pipe: 8 inch (200mm) long color field, 1/2 inch (13mm) high letters.
 - 2. 1-1/2 to 2 inch (40 to 50mm) Outside Diameter of Insulation or Pipe: 8 inch (200mm) long color field, 3/4 inch (19mm) high letters
 - 3. 2-1/2 to 6 inch (65 to 150mm) Outside Diameter of Insulation or Pipe: 12 inch (300mm) long color field, 1-1/4 (32mm) high letters
 - 4. 8 to 10 inch (200 to 250mm) Outside Diameter of Insulation or Pipe: 24 inch (600mm) long color field, 2-1/2 inch (63mm) high letters
 - 5. Larger than 10 inch (250mm) Outside Diameter of Insulation or Pipe: 32 inch (800mm) long color field, 3-1/2 inch (88mm) high letters

2.5 PIPE MARKERS

- A. Identify all piping, concealed or exposed, with plastic pipe markers, plastic tape markers or stenciled painting.
- B. Pipe Markers shall comply with ANSI / ASME A13.1 2007 "Scheme for the Identification of Piping Systems" and be installed as required and indicated below using legends spelled out fully with few abbreviations and directional arrows to indicate flow. Arrows must have the same background color as the pipe marker legend, or be incorporated into the pipe marker.
- C. Pipe marker color shall conform to ANSI Z535.1 "Safety Color Code"
- D. Minimum information indicating flow direction arrow and identification of fluid being conveyed as follows:

Pipes carrying unfiltered water to be labeled as:	RAW WATER
Pipes carrying filter water to be labeled as:	FILTERED WATER
Backwash piping labeled as:	BACKWASH
Chlorine piping labeled as:	CHLORINE
Ozone gas piping labeled as:	OZONE
Acid piping labeled as:	ACID
Soda Ash piping labeled as:	BASE

- E. Plastic Pipe Markers: Supply and install factory fabricated, semi rigid plastic pipe marker.
 - 1. Pipes with an overall diameter of 6" or less (including insulation), shall be marked with a wrap-around pipe marker formed as a pre-tensioned device to extend 360° around the pipe at each location. Marker to be equipped with a ½" strip of adhesive on the inside to further secure the marker in a permanent position.
 - 2. For pipes with an overall diameter greater than 6" (including insulation) provide a semi rigid plastic strap-on pipe marker with a height no less than 3 times the letter height supplied with no less than two nylon straps to secure the marker in place
- F. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings in contrasting color. Pipe must be clean and dry prior to placement to ensure adhesion. Flow directional arrow markings shall wrap completely around pipe for pipes with an overall diameter of 6" or less (including insulation) or wrap no less than 20" around on pipe larger than 6" diameter.
- G. Underground Plastic Pipe Markers: Provide bright colored continuously printed plastic ribbon tape identifying flow direction and fluid content. Tape shall be minimum 6 inches (150mm) wide by 4 mil (0.1mm) thick with a minimum tensile strength of 120 lbs, manufactured for direct burial service resistant to alkaline, acids, and other destructive agents usually found in soil.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. All surfaces that are to receive adhesive applied mechanical identification nameplates or adhesive pipe marking tape should be clean and dry prior to application.

3.2 INSTALLATION

- A. Equipment Name Plates
 - 1. Install plastic name plates with either 2 mil. permanent double faced adhesive covering entire surface of the nameplate or with stainless steel mechanical fasteners.
 - 2. Identify pumps, filters, controllers, generators, and all other equipment with plastic name plates
 - 3. Identify control panels and major control components outside panels with plastic name plates
- B. Valve Tags
 - 1. Attach each valve tag using the following solid brass (or other suitable material approved by the engineer) products: Jack chain, 1-½" "S" hooks, or #6 beaded chain.

2. Attach in a manner that tags are easily visible but do not obstruct the operation of the valve.
- C. Stencils
 1. Apply stencil painting in accordance with the manufacturer's instructions
- D. Pipe Markers
 1. Mark pipe in accordance with manufacturer's instructions.
 2. Install identifying markers/stencils in clear view so they are visible for a normal standing position and align with axis of piping.
 3. Spacing between identifying markers/stencils not to exceed 20 feet (6m). Install above and below every floor penetration and on either side of every wall penetration and insure there is at least one marker per pipe in every room. Install pipe markers insuring visibility at each primary valve, branch and any change in piping direction.
 4. Flow directional arrow markings shall wrap completely around pipe for pipes with an overall diameter of 6" or less (including insulation) or wrap no less than 20" around on pipe larger than 6" diameter.
 5. Install underground plastic pipe markers 6 to 8 inches (150 to 200mm) below finish grade, directly above buried pipe

END OF SECTION

SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS

PART 1 - GENERAL**1.1 SUMMARY****A. This section includes the following:**

1. Pump Performance
2. Fresh Water Pumps
 - a. End Suction, Long Coupled, Centrifugal Pumps
 - b. End Suction, Close Coupled, Centrifugal Pumps
 - c. Submersible Pumps
 - d. Vertical Turbine Pumps
 - e. Axial Flow and Mixed Flow Pumps
3. Salt Water Pumps
 - a. End Suction, Long Coupled, Centrifugal Pumps
 - b. Axial Flow and Mix Flow Pumps
 - c. Magnetic Drive Pumps

B. Related Sections:

1. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
2. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
3. SECTION 13 1404 – WATER FEATURE WHITE GOODS
4. SECTION 13 1501 – WATER FEATURE MECHANICAL IDENTIFICATION
5. SECTION 13 1503 – WATER FEATURE FILTERS
6. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
7. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
8. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
9. SECTION 13 1507 – WATER FEATURE HEATERS
10. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
11. SECTION 13 1509 – WATER FEATURE CHILLERS
12. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
13. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
14. SECTION 13 1513 – WATER FEATURE LOW PRESSURE AIR SYSTEMS
15. SECTION 13 1515 – AQUARIUM ACCESSORY EQUIPMENT
16. SECTION 13 1602 – WATER FEATURE CONTROLS
17. SECTION 13 1609 – WATER FEATURE DISCONNECTS, MCC, AND STARTERS

C. References:

1. ANSI B16.5 – STANDARDS OF PIPES AND FITTINGS
2. ASTM A48 – STANDARD SPECIFICATION FOR GRAY IRON CASTING
3. ASTM A53 – STANDARD SPECIFICATION FOR PIPE, STEEL, BLACK AND HOT-DIPPED, ZINC-COATED, WELDED AND SEAMLESS
4. ASTM A108 – STANDARD SPECIFICATION FOR STEEL BAR, CARBON AND ALLOY
5. ASTM A242 – STANDARD SPECIFICATION FOR HIGH-STRENGTH LOW ALLOY STRUCTURAL STEEL
6. ASTM B108 – STANDARD SPECIFICATION FOR ALUMINUM-ALLOY PERMANENT MOLD CASTING
7. AMERICAN WATER WORKS ASSOCIATION (AWWA) – SPECIFICATION E101-88
8. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) 70 or NATIONAL ELECTRICAL CODE (NEC)
9. NATIONAL SANITATION FOUNDATION (NSF) STANDARD 50
10. Occupational Safety and Health Administration (OSHA) Regulations
11. UNDERWRITERS LABORATORIES (UL)

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
 - B. Product Data: Submit manufacturer’s literature including pump and motor general assembly, dimensions, weights, clearances, service connections, wiring diagrams and controls.
 1. Provide pump curves showing performance characteristics of pump and system, operating point indicated, required NPSH and efficiency curves.
 2. Provide name plate data and ratings
 - C. Shop Drawings: Indicated layout, clearances, and methods of assembly and installation
 - D. Operation and Maintenance Data: Provide manufacturer’s installation instructions, and specifications, start-up procedures, assembly drawings, troubleshooting check lists, scheduled maintenance recommendations, replacement parts list and repair data
 - E. Warranty: Submit manufacturer’s warranty and ensure forms have been completed in the owner’s name and registered with the manufacturer.
 - F. Manufacturer’s Certification: Submit documentation from the manufacturer certifying that pumps conform with NSF 50 guidelines
- 1.3 QUALITY ASSURANCE
- A. Installer Qualifications: Company specializing in performing the Work of this Section with a minimum five (5) years documented experience
 - B. Comply with all applicable requirements of Division 16 Sections
 - C. Comply with NFPA 70 and local energy codes
 - D. Comply with BSEN and local energy codes
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Coordinate delivery with installation time to assure minimum holding time
 - B. Accept pumps and components on site in factory packaging. Immediately upon receipt of shipment, inspect, and check for damage
 - C. Protect pumps and components from physical damage including effects of weather, water, and construction debris
 - D. Store pumps in accordance to Manufacturer’s recommendations
- PART 2 - PRODUCTS**
- 2.1 PUMP PERFORMANCE
- A. Provide pumps matching discharge, electrical, and performance characteristics as shown on the equipment schedules on the Contract Documents
- 2.2 FRESH WATER PUMPS
- A. End Suction, Long Coupled, Centrifugal Pumps
 1. Acceptable Manufacturers
 - a. Marlow Pumps
 - b. PACO Products
 - c. Peerless Pump
 2. Casing:
 - a. Class 35 (minimum) cast iron
 - b. Hydro-statically tested per the Hydraulic Institute Standards

- c. Connections to comply with ASME B16.1 and ANSI 125/250 psi flanges for suction and discharge
 - d. Casing Wear Ring: Bronze, replaceable
3. Impeller:
 - a. Enclosed type cast bronze, statically and dynamically balanced
 - b. Diameter not greater than 90 percent of the casing cut-water diameter
4. Mechanical Seal
 - a. Single, inside mounted, end face, BUNA N rubber bellows
 - b. All stainless steel springs and metal parts
 - c. Carbon rotating washer
5. Shaft and Shaft Sleeve
 - a. Carbon steel shaft, maximum 0.002 inch (0.05mm) deflection at 95% and 105% of capacity at maximum speed
 - b. Bronze shaft sleeve
 - c. Sleeve shall extend beyond mechanical seal flanges
6. Bearing Frame
 - a. One piece cast iron, fully supported on both coupling and pump ends
 - b. Single row, deep groove, greasable ball bearings
 - c. Bearings designed for 100,000 hour average life
 - d. Rubber slinger on shaft and lip seal in bearing housing
7. Pump and Motor Assembly
 - a. Rigid steel base plate, with open grouting area
 - b. Factory aligned prior to shipment
 - c. OSHA approved coupling guard
 - d. Coupling
 - i. Woods Sureflex for constant speed applications
 - ii. Falk Steelflex for variable speed applications
 - e. Pump motor to be Totally Enclosed Fan Cooled (TEFC) high efficiency motor
 - f. Motor to have Class F insulation with temperature rise as specified by NEMA standards for class of insulation used and shall have a 1.15 service factor
 - g. Motor noise level to be less than 80 dBA at 3 feet (1m) or provide with a sound shroud
 - h. Reduced voltage starting, squirrel cage induction type
8. Basket Strainer
 - a. Acceptable Basket Strainer Manufacturers
 - i. Mer-Made Filter
 - ii. Neptune Benson Guardian
 - iii. Fluidtrol Process Technologies
 - b. All fiberglass body with corrosion liner on all interior surfaces and flange faces
 - c. ANSI Standard flanged inlet sized to pipe
 - d. ANSI Standard eccentric reducing outlet sized to match pump inlet
 - e. Provide a quick release to allow strainer basket to be removed quickly and easily. Release to be made of stainless steel bolts with fiberglass knobs\
 - f. V-wire 304 stainless steel basket with 3/16 inch (5mm) rectangular holes and 75% open area. Holes in the basket shall not be larger than 50 percent of minimum opening size of the pump it is protecting

- g. Provide a ¼ inch (6mm) Ball Cock Valve to be installed in the top of the strainer or lid to relieve trapped air
- B. End Suction, Close Coupled, Centrifugal Pumps
 1. Acceptable Manufacturers
 - a. Pentair
 - b. Hayward
 - c. Sta-Rite
 2. Casing
 - a. Molded from glass reinforced, corrosion-resistant thermoplastic with Bronze Wear Ring
 3. Impeller
 - a. Polycarbonate
 4. Mechanical Seal
 - a. Ceramic
 5. Shaft and Shaft Sleeve
 - a. Stainless steel with neoprene sleeve
 6. Pump and Motor Assembly
 - a. Mounted on molded glass reinforced, corrosion resistant thermoplastic supporting both pump and motor ends
 - b. Motor to have Class F insulation with temperature rise as specified by NEMA Standards for class of insulation used and shall have a 1.15 service factor
 - c. Motor noise level to be less than 80 dBa at 3 feet (1m) or provided with a sound shroud
 7. Basket Strainer
 - a. Body to be integral with pump housing
 - b. Transparent acrylic or Plexiglas lid with an ethylene propylene "O" ring
 - c. Quick release to allow strainer basket to be removed quickly and easily
 - d. 304 stainless steel basket with 3/16 inch (5mm) rectangular holes and 75% open area. Holes in basket shall not be larger than 50 percent of minimum size of the pump it is protecting
 - e. Provide ¼ inch (6mm) Ball Cock Valve to be installed in top of the strainer or lid to relieve trapped air
- C. Submersible Pumps
 1. Acceptable Manufacturers
 - a. PACO Products
 - b. Peerless Pumps
 - c. Flygt Pumps
 2. Housing
 - a. Heavy duty corrosion resistant cast iron
 3. Impeller
 - a. One piece, close grain, Class 30 cast iron
 - b. Non-clog design free of blowholes and imperfections
 - c. Capable of passing a 3 inch (75mm) sphere
 - d. Statically and dynamically balanced

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4. Upper/Lower Mechanical Seals
 - a. Carbon/Ceramic seal faces
 - b. BUNA N Elastomers
 - c. Stainless steel springs and hardware
 - d. Shaft:
 - i. One piece, oversized stainless steel shaft
 - e. Bearings
 - i. Single row, deep grooved, permanently lubricated ball bearings
 - ii. Bearings design for 17,500 hour average lift
 - f. Motor
 - i. Pump and Motor shall be of adequate design to provide proper heat transfer and cooling required by the motor at maximum rate power
 - ii. Motor shall be rated for continuous submerged duty service
 - iii. Motor shall be non-overloading across the entire anticipated operating range of the system curve without the use of the service factor
 - iv. Motor shall be UL Approved
 - g. Rail System
 - i. Pump shall be provided with a rail disconnect system to facilitate removal and reinstallation of the pump from a wet well for inspection or service without disconnecting or disturbing the discharge piping or need for personnel to enter the wet well
 - ii. Rail system shall include guide brackets, guide rails, support brackets and required lifting devices and all required accessories to remove and install the pump
 - h. Controls
 - i. All controls shall be in accordance with the Contract Electrical Drawings and all applicable sections of Division 16
 - ii. Standard lift station controllers are not acceptable, unless specifically approved by the Engineer
 - D. Vertical Turbine Pumps
 1. Acceptable Manufacturers
 - a. PACO Pumps
 - b. Peerless Pump
 - c. Ingersoll-Dresser
 2. Discharge Head Assembly
 - a. Cast iron or fabricated steel surface type, 125/250 lb (57/114 kg) discharge flange to support motor, column, shaft and pump assembly
 - b. Flanged column assembly connections
 - c. Fabricated steel sole plates
 - d. Tapped lubricated water drain line connections
 - e. Cast iron stubbing box
 - i. Bronze removable stuffing box bushing
 - ii. Galvanized split gland, T-bolts with stainless steel clips and brass nuts
 - iii. Synthetic packing rings, compressed around pump shaft, lubricated by pumped water
 - f. Two piece top shaft, 410 stainless steel coupling, and shaft slinger

- g. Adjustable top shaft nut at top of motor
- 3. Column Assembly
 - a. Column pipe and line shafting furnished in flanged interchangeable section not over 10 feet (3m) in length
 - b. Friction loss in column shall not exceed 5 feet (1.5m) per 100 feet (30m) at rated pump capacity
 - c. Weight and size of column per AWWA Specification E101-88
 - d. Line Shafting
 - i. Type 416 Stainless Steel (minimum of 1 inch (25mm) diameter) sized to operate pump without distortion or vibration
 - ii. Type 410 Stainless Steel coupling(s)
 - e. Bronze bearing retainers, retained by butted pipe ends
 - f. Water-lubricated, cut less rubber bearings
- 4. Pump Bowl Assembly
 - a. Close grained cast iron, minimum tensile strength 30,000 psi (200 MPa) free from blow holes, sand holes, and all other faults
 - b. Coated inside with smooth vitreous enamel to reduce friction losses, corrosion and sand wear
 - c. Each intermediate bowl to contain a bronze bearing and a neoprene bearing
 - d. Lateral bowl wear ring
 - i. Resilient neoprene ring, reinforced with an imbedded steel core to eliminate impeller skirt wear
 - e. Impellers
 - i. Bronze enclosed type only, hydraulically balanced, securely fastened to impeller shaft with steel taper bushing
 - f. Impeller shaft
 - i. Stainless steel, not less than 12 percent chrome
- 5. Strainer
 - a. Clip-on type galvanized/316 stainless steel basket strainer
 - b. Openings in strainers of proper size to exclude anything large enough to clog impeller
 - c. Minimum open area of four (4) times the impeller eye area
- 6. Motor
 - a. Vertical hollow shaft, high thrust type, reduce voltage, squirrel cage induction type
 - b. Enclosure suitable for a continuous operation at maximum rated rotations per minute (RPM)
 - c. Pump horsepower requirements shall not exceed motor nameplate rating at any point on pump performance curve
 - d. Service factor of a minimum 1.5
 - e. Non-reversing ratchet
 - f. Thrusting bearing designed for the application and able to carry weight of shafting, impellers and hydraulic down thrust
 - g. Bearing assembly oil or grease lubricated
 - h. Lower bearing locked in position to prevent radial movement
 - i. Motors to be inverter duty
- 7. Factor Assembly

- a. Closed coupled vertical pump shall be factory assembled of overall lengths does not exceed 10 feet (3m) from top of discharge head to bottom of suction manifold
 - b. Motor and motor shaft shipped unmounted for field installation by the Contractor
- E. Axial Flow and Mixed Flow Pumps
 - 1. Acceptable Manufacturers
 - a. Cascade
 - b. PACO Pumps
 - c. Peerless Pumps
 - 2. Discharge Head Assembly
 - a. Long radius elbow or standard elbow with ANSI standard connection flange
 - b. Fabricated of Grade B Steel per ASTM A53. Include OSHA approved coupling guards. Include motor stand integral to discharge assembly
 - c. Tension Nut Body: Cast iron per ASTM A48, C1.30. Include OSHA approved coupling guards
 - d. Lock Ring: Bronze
 - e. Tension Nut: Cast iron per ASTM A48, C1.30
 - f. Tension Nut Body Bushing: Bronze
 - g. Coat entire assembly with epoxy coating
 - h. Adjustable top shaft nut at top of motor of steel ASTM A108, Grade C-1018
 - i. Head and Shaft Coupling: C. F. Steel ASTM B108, Grade C-1045, PSQ.
 - j. Water Lubricated
 - k. Minimum Thickness of ¼ inch (6mm)
 - 3. Column and Shaft Assembly
 - a. Column pipe and line shafting furnished in flanged interchangeable sections not over 10 feet (3m) in length
 - b. Friction loss in column shall not exceed 5 feet (1.5m) per 100 feet (30m) at rated capacity of pump
 - c. Column fabricated of Grade B Steel per ASTM A53
 - d. Line Shafting:
 - i. Type 416 Stainless Steel (minimum of 1 inch (25mm) diameter) sized to operate pump without distortion or vibration
 - ii. Bearing: Bronze
 - iii. Enclosing tube: Schedule 80 pipe per ASTM A53
 - iv. Line Shaft Coupling: Steel ASTM A108, Grade 1215
 - e. Water lubricated
 - 4. Pump Bowl Assembly
 - a. Bowl Shaft/Thrust Collar and Key: Stainless Steel ASTM A108, Type 416, PSQ
 - b. Epoxy coat all parts that come in contact with water
 - c. Discharge Bowl: Cast iron per ASTM M48, C1.30
 - d. Discharge Bowl Bushing: Bronze
 - e. Propeller: Bronze
 - f. Suction Bowl Bushing: Bronze
 - g. Suction Bowl: Cast iron per ASTM A48, C1.30
 - 5. Strainer
 - a. Clip-on type galvanized or 316L Stainless Steel basket strainer
 - b. Openings in strainer of proper size to exclude anything large enough to clog impeller
 - c. Minimum open area shall be four (4) times the impeller eye area

6. Motors
 - a. Vertical hollow shaft, high thrust type, reduced voltage, squirrel cage induction type
 - b. Enclosure shall be TEFC
 - c. Pump horsepower requirements shall not be exceed motor nameplate rating at any point on the pump performance curve
 - d. Minimum service factor of 1.5
 - e. Non-reversing ratchet
 - f. Thrust Bearing designed for the application and able to carry weight of shafting, impellers, and hydraulic down thrust
 - g. Bearing assembly oil or grease lubricated
 - h. Lower bearing locked in position to prevent radial movement
 - i. Motors to be inverter duty
7. Factory Assembly
 - a. Axial or mixed flow pump shall be factory assembled if overall length does not exceed 10 feet (3m) from top of discharge head to bottom of suction manifold
 - b. Motor and motor shaft shipped unmounted for field installation by the Contractor

2.3 SALT WATER PUMPS

- A. End Suction, Long Coupled, Centrifugal Pumps
 1. Acceptable Manufacturers
 - a. MET PRO Corporation - Fybroc
 - b. Ingersoll-Dresser
 - c. Agral Pumps
 2. Casing:
 - a. High grade glass reinforced (GRP) construction
 3. Impeller:
 - a. Statically balanced semi-open design
 4. Shaft and Sleeve:
 - a. Heat treated polygon Type 4140 Steel shaft with non-metal sleeve, and oil lubricated bearings with external oilers
 5. Pump and Motor Assembly
 - a. Pump mounted on a molded glass reinforced vinyl ester base with integral drain rim and mounting inserts
 - b. Couplings to be flexible spaces type permitting disassembly and inspection without disturbing pump and piping, drives, or alignment
 - c. Couple guards to meet OSHA standards
 - d. Pump motor to be Totally Enclosed Fan Cooled (TEFC) high efficiency motor
 - e. Motor noise level to be less than 80 dBA at 3 feet (1m), or provided with a sound shroud
 - f. Reduced voltage starting, squirrel cage induction type
- B. Axial Flow and Mixed Flow Pumps
 1. Acceptable Manufacturers
 - a. Flygt Pumps
 - b. MWI
 2. Propeller bowl shall be a single stage, shop assembled unit consisting of the following:

- a. Venturi Housing: Manufactured of alloy steel fitted with a machined, removable housing liner of 316L Stainless Steel
 - b. Stainless Steel Liner
 - c. Stainless Steel Propeller Blades: Manufactured of 316L Stainless Steel. Shall be statically and dynamically balanced and secured firmly on the taper shaft with alignment key and locknut
 - d. Propeller Shaft: Machined from high tensile strength, solid stainless steel bar stock and shall conform to ASME code for transmission shafting to transmit full load torque and shall have additional safety factor for shock loads
 - e. Bearings: Multiple angular contact bearings to prevent axial and radial misalignment of vibration of the shaft
 - f. The shaft bearing shall be sealed, self-lubricating by low pressure hydraulic oil designed for bearing life of 50,000 hours of use
 - g. The propeller shaft and bearing shall be contained in a machined bearing housing centrally supported by flow straightening vanes in the propeller bowl assembly and shall be protected against sand particle intrusion with bronze restrictor rings
 - h. Bearing shall be designed to accept thrust in either direction, along with a reverse rotation mechanism
 3. Suction Bell Assembly
 - a. Manufactured from alloy steel and conforming to ASTM A242
 - b. Shall have a minimum inlet diameter of 1.5 times the propeller diameter
 - c. Bell shall be constructed so to minimize vortex formation by maintaining equal pressure and velocities across the entrance
 - d. The entrance shall be manufactured with cross bars placed across the bell mouth to prevent entrance of large sticks, logs, or debris
 - e. Inlet bell face shall be parallel to the water surface regardless of the angle of installation
 4. Discharge Tube and Head Assembly
 - a. Manufactured of abrasive resistant steel conforming to ASTM A242
 - b. The complete pump assembly shall be painted inside and outside with black bitumastic enamel
 5. Hydraulic Motor:
 - a. Shall be factory assembled consisting of the assembly housing, hydraulic motor, propeller shaft coupling, inlet and outlet port pipe connections
 - b. Assembly housing shall be shop manufactured of alloy steel conforming to ASTM A242, and shall be fitted with connecting flanges for assembly with the pump bowl assembly and the discharge pipe assembly
 - c. The housing assembly shall contain a hydraulic motor which shall be coupled to the mating propeller shaft by means of jaw or chain type coupling
 - d. The bearings, shaft, and coupling shall be totally enclosed and high pressure sealed to permit totally submerged operation in any position
 - e. The hydraulic motor shall be provided with inlet and outlet port pipe connections extended from hydraulic motor through the assembly housing and shall terminate with female quick coupling connections on each end
 - f. Hydraulic motor shall be mounted on the discharge side of the propeller. Suction side installations shall not be allowed
- 2.4 MAGNETIC DRIVE PUMPS
- A. End Suction, Centrifugal Pumps
 1. Acceptable Manufacturers

- a. MET PRO Corporation - Fybroc
 - b. Hayward Industrial Products, Inc.
 - c. Little Giant Pumps
2. Casing:
 - a. High grade glass reinforced (GRP) construction
3. Impeller:
 - a. Statically balanced semi-open design
4. Shaft and Sleeve:
 - a. Ceramic shaft with imbedded magnets. Bushings shall be PTFE
5. Pump and Motor Assembly
 - a. Pump mounted on a molded glass reinforced vinyl ester base with integral drain rim and mounting inserts
 - b. Pump motor to be Totally Enclosed Fan Cooled (TEFC) high efficiency motor
 - c. Motor noise level to be less than 80 dBA at 3 feet (1m), or provided with a sound shroud
 - d. Reduced voltage starting, squirrel cage induction type

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine surfaces, substrates, and conditions for compliance with requirements of other sections in which the related Work is specified, and determine if surfaces, substrates, and conditions affecting performance of the Work of this Section are satisfactory. Do not proceed with the Work of this Section until unsatisfactory conditions have been corrected in a manner acceptable to the Installer. Starting installation shall constitute acceptance of surfaces, substrates, and conditions

3.2 INSTALLATION

- A. Install pumps and motors in strict compliance with the manufacturer's recommendations to insure manufacturer's warranty conditions are met
- B. Locate pumps in locations indicated on the Contract Documents. Mount pumps on concrete housekeeping pads with embedded anchor bolts. Build templates for pump mounting from actual base plates delivered to site with pump and motor
- C. Inspect pumps and remove any dirt or foreign material from the pump suction and discharge. Check motor to make sure not foreign objects have entered through fan and cooling openings
- D. Verify clearances around the pump meet the manufacturer's recommendations
- E. Pump and motor shall be leveled and grouted in place
- F. Piping connected to pump suction must be eccentric and aligned with the pump inlet. Piping connected to pump discharge must be concentric and aligned with the pump outlet
- G. Pipe enlargements at the pump suction and discharge must be made with reducer fittings. Bushing type fittings are not acceptable and will be replaced with eccentric or concentric reducers
- H. Check pump for alignment, lubrication, and rotation
- I. Provide drains for bases and seals, piped to and discharging into floor drains
- J. Provide connection to electrical service in accordance with all applicable sections of Division 16

3.3 FIELD QUALITY CONTROL

- A. Test entire system with pump manufacturer's representative present

- B. Test to include three point pump performance by measuring the amp draw and voltage, the discharge pressure and the rate of flow
- C. Rate of flow must be within 10 percent above the approved curve for acceptance
- D. Discharge pressure head must be within 5 percent above the approved curve for acceptance
- E. Submit three (3) copies of the test results to the Engineer

END OF SECTION

SECTION 13 1503 – WATER FEATURE FILTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. High Rate Sand Filters
 - a. Horizontal Tank Configuration
 - b. Vertical Tank Configuration
 - c. Sand Filter Media
 - d. Backwash Control Valving
2. Regenerative Media Filters
3. Cartridge Filters
4. Permanent Media Filters
5. Backwash Holding Tanks and Sumps

B. Related Sections:

1. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
2. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
3. SECTION 13 1501 – WATER FEATURE MECHANICAL IDENTIFICATION
4. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
5. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
6. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
7. SECTION 13 1506 – WATER FEATURE UV STERILIZER
8. SECTION 13 1507 – WATER FEATURE HEATERS
9. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
10. SECTION 13 1509 – WATER FEATURE CHILLERS
11. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
12. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
13. SECTION 13 1512 – WATER FEATURE COMPRESSED AIR SYSTEMS
14. SECTION 13 1602 – WATER FEATURE CONTROLS

C. References:

1. UNDERWRITERS LABORATORY, INC (UL) STANDARD 508 for Industrial Control Equipment
2. ANSI B16.5 – STANDARDS OF PIPES AND FITTINGS
3. ASTM A53 – STANDARD SPECIFICATION FOR PIPE, STEEL, BLACK AND HOT-DIPPED, ZINC-COATED, WELDED AND SEAMLESS
4. ASTM A108 – STANDARD SPECIFICATION FOR STEEL BAR, CARBON AND ALLOY
5. ASTM A242 – STANDARD SPECIFICATION FOR HIGH-STRENGTH LOW ALLOY STRUCTURAL STEEL
6. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) 70 or NATIONAL ELECTRICAL CODE (NEC)
7. NATIONAL SANITATION FOUNDATION (NSF) STANDARD 50
8. Occupational Safety and Health Administration (OSHA) Regulations

1.2 SUBMITTALS FOR REVIEW

A. SECTION 01 3300 – SUBMITTAL PROCEDURES

B. Product Data: Submit manufacturer's literature including printed recommendations, dimensions and sizes, installation instructions, specifications, startup procedures and maintenance schedules for the filters, control panels, auto flushing valves and accessories.

1. Indicate on each submittal which materials, models, data, and options are being selected

- C. Shop Drawings: Provide certified engineering drawings and calculations to demonstrate structural strength of filter vessels
- D. Operation and Maintenance Data: Provide manufacturer's installation instructions, specifications, start-up procedures, assembly drawings, troubleshooting checklists, scheduled maintenance recommendations, replacement parts list and repair data
- E. Manufacturer's Certification: Submit documentation from the manufacturer certifying that Control Console meets UL Standard 508, Industrial Controller
- F. Manufacturer's Certification: Submit documentation from the manufacturer certifying that the Filter Vessels conform with NSF Standard 50 guidelines
- G. Warranty: Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer
- H. Filter Manufacturers shall guarantee to repair or replace any filter tank, lateral, diverter, or internal header found defective due to any structural failure caused by delamination, fatigue, rust, scaling, corrosion, and UV rays for a period of five (5) years from date of final payment, except for Pentair Triton filters, which have one (1) year warranty.

1.3 REGULATORY REQUIREMENTS

- A. All Work shall conform to applicable state and local codes, specifically, local electrical and health codes as they apply to public water features

1.4 DELIVERY, STORAGE, AND HANDLING

- A. All components of the filter system shall be supplied in wooden crates to facilitate shipments, handling and/or storage on the job site
- B. Coordinate delivery with installation time to assure minimum holding time
- C. Accept filters and components on site in factory packing. Immediately upon receipt of shipment, inspect and check for damage
- D. Protect filters and components from physical damage including effects of weather, water, and construction debris

PART 2 - PRODUCTS

2.1 HIGH RATE SAND FILTERS

- A. Horizontal Tank Configuration
 - 1. Approved Manufacturers
 - a. Neptune-Benson
 - b. Paragon Aquatics
 - c. Astral Filter
 - 2. Shall be capable of filtering water rates of 15 gpm/sq ft (10 lps/sq m) and backwashing rates from 15 gpm/sq ft (10 lps/sq m) to 20 gpm/sq ft (13.5 lps/sq m) of the filter media area
 - 3. Backwash Cycle shall be accomplished by reversing the flow through the vessel using filtered water from adjacent vessel(s). Backwash with raw source water is not acceptable
 - 4. Horizontal Filter Systems include the following components:
 - a. Filter Vessel
 - b. Distribution Piping
 - c. Header Piping
 - d. Fastening Hardware
 - e. Automatic Filter Control Console

5. Filter Vessel:
 - a. Horizontal type pressure vessel for use with a single grade of media
 - b. Manufactured of filament wound fiberglass reinforced with premium isophthalic polyester
 - c. Consisting and inner corrosion barrier/liner wound with continuous strand fiberglass filaments wrapped in circumferential and longitudinal patterns
 - d. Coated with a minimum 20 mil (0.5mm) premium grade isophthalic gelcoat with UV inhibitor
 - e. Reinforced openings and penetrations with continuous filaments
 - f. Provide a drain in the bottom of the vessel to allow draining of the tank without having to expel the sand media
 - g. Access manhole shall be 12 inches (300mm) by 16 inches (400mm) into the vessel with yoke, cover and gasket fitted on the side to facilitate servicing of the vessel
 - h. Automatic internal and a manual external air relief system in the top of the vessel
 - i. Listed by NSF for a maximum flow rating of 20 gpm/sq ft (13.5 lps/sq m)
 - j. Rated for a design vacuum of 14.68 psi (101 kPa)
 - k. Vessels shall be designed and have provision for stacked installation configuration
6. Distribution Piping:
 - a. Influent and effluent connections shall be sized as shown on the Contract Documents
 - b. Influent and effluent pipes shall be fitted with Schedule 80 PVC flanged fittings with a minimum strength requirement of 1,500 lb-ft (207 kg-m) of bending moment and 200 lb-ft (28 kg-m) of torque
 - c. Internal distribution and collection system constructed of ABS plastic and Schedule 80 PVC pipe, fabricated with flow distributors threaded into Schedule 80 PVC pipe
 - d. All distributors and laterals shall be threaded and replaceable
 - e. Internal flow velocities of laterals not to exceed 2 feet (0.6m) per second at the design flow rate
 - f. All internal components shall be hydraulically balanced to prevent migration of filter media during the filtration cycle
 - g. Each tank shall uniformly fluidize media in backwash cycle without channeling or breakthrough at any one location
7. Header Piping:
 - a. All header piping and fittings to be constructed of Schedule 80 PVC
 - b. Piping and fittings to be connected with flanges
 - c. Flanges to meet ANSI Standard pattern and designed with a minimum strength requirement of 1,500 ft-lb (207 kg-m) of bending moment and 200 lb-ft (28 kg-m) of torque
 - d. Backwash control valve(s) shall be supplied with each filter
 - e. Provide a backwash sight glass with each filter system
 - f. Header piping shall include all piping and fittings which connect two or more filters and valves into a system to provide a single influent, effluent, and backwash connection point
 - g. Header piping and fittings shall be sized as shown on the Contract Documents
8. Fastening Hardware
 - a. All fastening hardware on flanges, man ways, viewing ports, etc. shall be 316L Stainless Steel
9. Automatic Filter Control System
 - a. Listed by UL as a filter controller under Standard 508, Industrial Controllers
 - b. Filter Control System shall consist of an automatic controller, with its associated temperature, pressure and flow sensors and backwash control valves

- c. Control System shall govern operation of the filter system with logic provided by a programmable microprocessor capable of maintaining program memory without need for power
- d. Ability to initiate an emergency telephone call in an alarm condition
- e. All components housed within a fully gasketed NEMA 4 hinged non-conductive enclosure featuring a security locking device, plus a view window
- f. Controller shall continuously monitor and be capable of displaying the following:
 - i. Filter Inlet Pressure in psi (kPa)
 - ii. Filter Outlet Pressure in psi (kPa)
 - iii. Differential Pressure in psi (kPa)
 - iv. Current Water Temperature in °F and °C
 - v. System Flow Rate in gpm (lps)
 - vi. Accumulated flow since last backwash cycle in gallons (liters)
 - vii. Elapse time since last backwash cycle
 - viii. Current time of day
 - ix. Current day and date
 - x. Mode of operation
- g. Controller shall provide the following features and functions
 - i. 7 day/24 hour ON/OFF energy saver timer clock to turn the system ON/OFF on a daily basis
 - ii. 7 day/24 hour backwash initiation time clock to allow backwash cycle to occur any time during the day on any day of the week
 - iii. Automatically initiate backwash cycle by user selection and setting of either:
 - 1. Differential Pressure
 - 2. Time
 - 3. Flow Rate
 - 4. Accumulated Flow
 - 5. Or combination of above
- h. Manually initiate a backwash cycle
- i. Fail-safe monitor and shut down if backwash cycle is interrupted or inhibit signal is received
- j. Backwash volume counter
- k. Provide control logic for the following controls allowing the controller to coordinate with accessory equipment
 - i. Controller only initiates backwash after confirming that there are no other systems already in backwash and that no other inhibit condition exists
 - ii. A "Fireman's Delay" contact that initiates a constant +24 VAC signal at a user adjustable time prior to the actual backwash cycle, and during the entire backwash cycle, and for a user adjustable time after the backwash cycle. (Used to shut down the ozone generator and heater before backwash cycle and delaying startup after backwash cycle.)
 - iii. A "Pump" contact that initiates a continuous signal during the entire backwash cycle. (Used to turn filter pump(s) off while switching valves if necessary)
 - iv. A "Valve" contact that initiates a continuous signal during the entire backwash cycle. (Used to move backwash control valve into correct position)
 - v. A "Sump" contact that initiates a continuous signal during backwash and for a user adjustable time after the backwash cycle is completed. (Used to start a sump pump as required)
- l. Easily accessible terminal hook-up board and switching to control accessory equipment

- m. Battery backup to maintain time and date in the event of a power failure
 10. Metal fasteners shall be Grade 316L Stainless Steel
 11. Provide gauge panel for two (2) oil pressure gauges for influent/effluent read outs
 - B. Vertical Filter Configuration
 1. Approved Manufacturers
 - a. Pentair Triton Commercial
 - b. Neptune-Benson
 - c. Hayward Industrial Products
 2. Shall be capable of filtering water rates of 15 gpm/sq ft (10 lps/sq m) and backwashing rates from 15 gpm/sq ft (10 lps/sq m) to 20 gpm/sq ft (13.5 lps/sq m) of the filter media area
 3. Backwash Cycle shall be accomplished by reversing the flow through the vessel using filtered water from adjacent vessel(s). Backwash with raw source water is not acceptable
 4. Vertical Filter System shall include the following:
 - a. Filter Vessel
 - b. Distribution Piping
 - c. Header Piping
 5. Vessel:
 - a. Constructed of molded colorfast polymeric material or seamless filament wound fiberglass reinforced plastic
 - b. Automatic air-relief valve
 - c. Drain port location in the bottom of the vessel
 - d. Inspection cover in the top of the vessel
 - e. Internal distribution piping to direct water evenly across the entire sand surface
 6. Distribution Piping:
 - a. Influent and effluent connections shall be sized as shown on the Contract Documents
 - b. Influent and effluent pipes shall be fitted with Schedule 80 PVC flanged fittings with a minimum strength requirement of 1,500 lb-ft (207 kg-m) of bending moment and 200 lb-ft (28 kg-m) of torque
 - c. Internal distribution and collection system constructed of ABS plastic and Schedule 80 PVC pipe, fabricated with flow distributors threaded into Schedule 80 PVC pipe
 - d. All distributors and laterals shall be threaded and replaceable
 - e. All internal components shall be hydraulically balanced to prevent migration of filter media during the filtration cycle
 - f. Each tank shall uniformly fluidize media in backwash cycle without channeling or breakthrough at any one location
 7. Header Piping:
 - a. All header piping and fittings to be constructed of Schedule 80 PVC
 - b. Piping and fittings to be connected with flanges
 - c. Flanges to meet ANSI Standard pattern and designed with a minimum strength requirement of 1,500 ft-lb (207 kg-m) of bending moment and 200 lb-ft (28 kg-m) of torque
 - d. Backwash control valve(s) shall be supplied with each filter
 - e. Provide a backwash sight glass with each filter system
 - f. Header piping shall include all piping and fittings which connect two or more filters and valves into a system to provide a single influent, effluent, and backwash connection point
 - g. Header piping and fittings shall be sized as shown on the Contract Documents

2.2 SAND FILTER MEDIA

- A. Grade #20 Silica Sand conforming to the following shall be used for both horizontal and vertical sand filters:

1. Effective size: 0.018 inch (0.45mm)
2. Uniformity Coefficient: 1.5
3. Mean Diameter: 0.0243 inch (0.61mm)
4. Standard Deviation: 0.00432 inch (0.11mm)
5. Conforming to the following gradation:

Sieve No. (U.S. Series)	Opening Size Inches (mm)	Percent Retained on Sieve (% by weight)
20	0.033 (0.838)	2
30	0.023 (0.584)	58
40	0.016 (0.406)	36
50	0.012 (0.305)	4

- B. Activated Filter Media (AFM)

1. Filter media for both horizontal and vertical sand filters shall be AFM engineered & activated glass media produced by Dryden Aqua.
2. Supply and install Grade 1, Grade 2 and Grade 3 AFM in quantities appropriate for the specific filter according to filter manufacturer specified media levels.
 - a. Grade 3 media (2.0-4.0mm) shall be used as underlayment support below filter laterals. Fill to mid-point of top of lateral assembly as recommended by filter manufacturer.
 - b. Grade 2 media (1.0-2.0 mm) shall be used as a base layer above laterals approximately 20-30% of total filter bed depth (above laterals).
 - c. Grade 1 media (0.4-1.0 mm) shall be used as the top layer filling to manufacturer specified bed depth, 70-80% of total bed depth (above laterals) leaving required freeboard above media bed.

1.2 BACKWASH CONTROL VALVING

- A. Acceptable Manufacturers

1. ASAHl AMERICA
2. Approved Filter Manufacturer
3. Approved Equal

- B. Horizontal Sand Filter System

1. Motorized Butterfly Valve
 - a. Electric actuator with reversing type motor and manual override
 - b. Integral thermal overload protection with auto-reset
 - c. Permanently lubrication gear train
 - d. Adjustable travel-stop limit switches
 - e. Capable of being operated by a low voltage signal from filter control center and separate Hand-Off-Auto (HOA) switch
 - f. Fully field adjustable closure stops to limit the percent of valve closure to assure proper system flow rate
2. Pneumatically Actuated Butterfly Valve and Pneumatic Actuator with manual override
 - a. Double Piston, Rack and Pinion Design Double Acting Air-to-Air Operation
 - b. ISO mounting pattern for valve with NAMUR mounting pattern for solenoids and accessories

- c. Valves 4 inches (100mm) and smaller to include flats on actuator shaft for manual override. Valves larger than 4 inches (100mm) to include de-clutchable gear operated manual override
 - d. Actuator bodies to be of highly corrosion resistant glass filled polyamide or aluminum with Rilsan coating
 - e. Solenoid valve to be NEMA IV, with manual override and speed controls
 - f. Actuators shall be incorporated valve position limit switches coupled to the valve shaft and indicating to the PLC the fully OPEN or CLOSED position of the valve
 - g. Fully field adjustable closure stops to limit the percent of valve closure to assure proper system flow rate
 - h. Supply air pressure regulator to be provided, properly rated for working range of actuator
 - i. Supply air working range 80-120 psi (550-830 kPa)
 - j. Each actuator air line to be supplied with a ball valve for isolation
 - k. Actuator Seals shall be BUNA N
 - l. Integral thermal overload protection with auto-reset
 - m. Permanently lubricated gear train
 - n. Capable of being operated by a low voltage signal from filter control center and separate HOA switch
 - 3. Tandem Butterfly Valves (up to 14 inches (350mm) diameter)
 - a. Body construction shall be one piece thermoplastic PVC conforming to Cell Classification 12454. Body shall be wafer type conforming to ANSI B 16.5 bolt circle
 - b. Disc shall be PVC or Polypropylene
 - c. Stem shall be 316L Stainless Steel non-wetted type
 - d. External metallic trim shall be 300 Series Stainless Steel, epoxy or powder coated
 - e. Seals: Full Seat design, Isolating stem from median and functioning as a gasket for mating flanges. Material shall be EPDM
 - f. Valves shall have bubble tight shut-off with the following pressure ratings:
 - i. Sizes up to 10 inches (250mm) – 150 psi (1.0 MPa)
 - ii. Size 12 inches (300mm) and larger – 100 psi (690 kPa) based on ambient Temperature
 - g. Tandem Butterfly arrangement shall consist of two (2) butterfly valves mounted to a flanged T-style fitting
 - h. Tandem mounting kit and hardware shall be manufactured Stainless Steel, and allow independent adjustment of opening and closing of valves
 - i. Tandem mounting kit shall be of a design that fully supports valves and actuator
 - j. Valves shall operate in opposite directions (i.e. one valve is opening as the other valve is closing)
 - k. All valves shall be tested by the manufacturer prior to shipment. Test documents shall be available upon request
- C. Vertical Sand Filter System
- 1. Multiport Type Control Valve
 - a. Include the following settings:
 - i. Filter: Normal operation
 - ii. Backwash: For cleaning filter sand bed
 - iii. Rinse: For rinsing after backwash
 - iv. Waste: Bypassing filter for draining or lowering pool water
 - v. Recirculate: Water bypasses filter
 - vi. Closed: Shuts off flow from the pump to the filter
 - b. All construction materials shall be either PVC, CPVC, ABS, or similar thermoplastic material

- c. Control Valves shall be sized to meet the flow requirements of the filter system with minimal pressure loss of less than 10 psi (69 kPa)
 - d. Control Valves shall include a integral sight glass sufficient in size to enable operator visual inspection of the backwash water
 - e. Selection of the Control Valve setting shall be operated with a level action handle for ease of function selection
 - f. Selection of the Control Valves shall be provided with a liquid filled pressure gauge
 - g. Backwash Control Valves shall be proven to operate properly with filter system selected and approved for use by the filter manufacturer
 - 2. Tandem Butterfly Valves (up to 8 inches (200mm) diameter)
 - a. Body construction shall be one piece thermoplastic PVC conforming to Cell Classification 12454. Body shall be wafer type conforming to ANSI B 16.5 bolt circle
 - b. Disc shall be PVC or Polypropylene
 - c. Stem shall be 316L Stainless Steel non-wetted type
 - d. External metallic trim shall be 300 Series Stainless Steel, epoxy or powder coated
 - e. Seals: Full Seat design, Isolating stem from median and functioning as a gasket for mating flanges. Material shall be EPDM
 - f. Tandem Butterfly arrangement shall consist of two (2) butterfly valves mounted to a flanged T-style fitting
 - g. Tandem mounting kit and hardware shall be manufactured Stainless Steel, and allow independent adjustment of opening and closing of valves
 - h. Tandem mounting kit shall be of a design that fully supports valves and actuator
 - i. Valves shall operate in opposite directions (i.e. one valve is opening as the other valve is closing)
 - j. All valves shall be tested by the manufacturer prior to shipment. Test documents shall be available upon request
- 1.3 REGENERATIVE FILTER SYSTEMS
- A. Approved Manufacturers
 - 1. Neptune-Benson – Defender 2 filter system
 - B. Filters shall be sized to meet the filtering flow rates shown on the Contract Documents and fit spatially in the footprint provided in the Contract Document
 - C. All controls and valving must be accessible for correct operation and regular maintenance as outlined in the manufacturer's Operation and Maintenance Manual
 - D. Components:
 - 1. Filter Vessel
 - 2. Flexible Tube Filter Elements
 - 3. Internal Components
 - 4. Bump Mechanism
 - 5. Vacuum Transfer System
 - 6. Sight Glass
 - 7. Pressure Gauge Panel
 - 8. Inspection (Viewing) Window
 - 9. Valves and Automatic Regeneration Controller
 - 10. Filter/Regulator
 - 11. Air Compressor
 - 12. Automating Pneumatic Valves
 - E. Filter Vessel

1. Vessel shall be suitable for 50 psi (345 kPa) working pressure and hydrostatically tested to a minimum of 75 psi (517 kPa)
 2. Vessel material can be:
 - a. Type A-26 Carbon Steel with an elastomeric polyurethane lining
 - b. 316L Stainless Steel
 - c. Fiber wound composite structure (provide specification of process and materials for review by the Design Engineer)
 3. Welds performed by qualified operators and result in fully penetrated welding free of ripples, grooves, overlaps, abrupt ridges or valleys, and be chipped and brushed clean leaving a smooth surface
 4. Support Legs shall be removable for shipping and access into the mechanical room
 5. Gasket materials shall have a sealing capacity of a minimum 1.5 times the design pressure
 6. Equipped with a UL listed grounding lug
 7. Provide bracket for mounting of automatic controller, lifting davit for head assembly, gauge panel, filter regulator, vacuum transfer blower, and vacuum hose rack
 8. Filter tank and associated liner shall carry a 15 year warranty
 9. Coat exterior of tank with high solids enamel with a total film thickness of 4-6 mils (0.010-0.015mm)
 10. Provide a minimum 16 oz. (0.47 liter) of enamel touch up paint with each filter tank supplied
- F. Internal Components
1. All metal directly exposed to the pool water shall be 316L Stainless Steel
 2. Filter elements shall be fabricated of multi-filament high strength polyester braid
 3. The filter influent connection shall be fitted with a stainless steel flow diversion assembly to eliminate disturbance to the filter element during operation
- G. Bump Mechanism
1. Pneumatically operated
 2. Externally mounted on the top of the filter vessel
 3. Provides means of dislodging the media and accumulated solids which then recoats the filter element
- H. Vacuum Transfer System
1. Provide a vacuum transfer system to allow automatic recharging of media in the filter from either a bag or bulk media storage container
 2. Vacuum Blower components
 - a. TEFC 0.5 hp (0.37 kW), 115/203V, single phase motor, 50/60 Hz
 - b. In-line filter to prevent dust and media from being drawn into the blower
 3. Provide three (3) 1.5 inch (32mm) Schedule 80 PVC ball valves for assembly of transfer system
 4. Provide assembly instructions of vacuum system
 5. Provide 10 feet (3m) of 1.5 inch (32mm) vacuum hose with fittings
- I. Sight Glass
1. Provide one (1) standard backwash sight glass and install in recirculation lines based on the manufacturer's recommendations
- J. Automatic Controller
1. The automatic controller shall provide total control of the system's filtration and regeneration cycles, and provide all necessary equipment interlocks and timing mechanisms to execute the filter program

2. The controller shall contain a microprocessor that will activate the following functions of the system:
 - a. Bump Cycle / Manual or Automatic
 - b. Precoating of the filter elements
 - c. Stopping and starting of the main recirculation pump
 - d. Opening and closing of pneumatically operated valving
 - e. Vacuum Transfer System
 - f. Heater Cool Down Delay
 - g. Auxiliary contacts to interlock chemical control or other equipment
 - h. Keyed switch to activate continuous, intermittent bump cycle for element cleaning
 3. The controller panel shall display the following functions:
 - a. Filter status
 - b. Precoat status
 - c. Recirculation Pump status
 - d. Vacuum Transfer Pump status
 - e. System Power
 4. The controller enclosure shall be NEMA Type 12 industrial enclosure
- K. Filter/Regulator
1. Each filter shall include a combination filter/regulator. The regulator shall be adjustable from 0-120 psi (0-827 kPa) ½ inch (15mm) F.P.T. connections shall be provided for field installation of air lines
- L. Air Compressor
1. Provide an air compressor for each solitary filter in the mechanical room
 2. Provide two (2) air compressor in each room where multiple filter tanks are installed in the same mechanical room
 3. The system will require one (1) air compressor that shall include
 - a. 6 gallon (22.7 liter) tank
 - b. 2 hp (1.5kW), electric motor, 120V, single phase
 - c. 2.7 CFM (76.4 lpm) at 90 psi (620 kPa)
 - d. Oil free pump
 - e. One (1) water separator with automatic drain shall be included for each air compressor supplied. ½ inch (15mm) F.P.T. connections shall be provided for field installation of air lines
 - f. Enough pneumatic hose to activate each filter and valve in the mechanical room where the filter is installed
- M. Automating Pneumatic Valves
1. All valves 3 inches (80mm) to 12 inches (300mm):
 - a. Constructed with cast aluminum ASTM S12A housing and fully coated with Rilsan on all interior and exterior surfaces
 - b. Internal components include EPDM resilient lining, Rilsan coated ductile iron disc and T304 stainless steel shaft
 2. Valves 14 inches (350mm) and larger shall be constructed with cast iron housing and epoxy coated ductile iron disc
 3. Valves shall be Dominion Butterfly Valves and shall be provided for the influent, effluent, and precoat lines.
 4. Pneumatic Actuators

- a. Each filter shall include pneumatic actuators for one (1) influent valve, one (1) effluent valve, and one (1) precoat valve
- b. Double acting with valve mounted drilling to ISO 5211
- c. Include two (2) ¼" (6mm) FPT ports for open / close connections. Flow control valves with quick connect fittings shall be provided at each port to allow speed control adjustment for the open / close function of the actuators
- d. Materials of Construction
 - i. Body: Aluminum alloy, extruded according to ASTM 6063, anodized according to UNI 4522
 - ii. Ends: Die-cast in aluminum alloy according to ASTM B179, epoxy-polyester coated
 - iii. Pistons: Die-cast in aluminum alloy according to ASTM B179
 - iv. Pinion: Nickel-plated steel
 - v. Slideways: Acetal resin (LAT LUB 731320T)
 - vi. Fasteners: 304 Stainless Steel
 - vii. Springs: Epoxy Coated Steel, pre-compressed
 - viii. Seals: NBR Nitrile rubber
 - ix. Lubricant: MoS2
- e. The actuators shall be factory lubricated to allow for 1,000,000 maneuvers
- f. The actuators shall have adjustable travel stops for both directions
- g. Working temperature limits: 4 °F (-15 °C) to 186 °F (85 °C)

N. Regenerative Filter Media

- 1. Media shall be expanded perlite with a median particle size of 37 microns. Percentage retained on a +150 Tyler Mesh shall not be less than 8% or more than 25%. Darcy permeability shall be between 1.2 and 1.85
- 2. The media shall contain no more than 1/10% (0.001) of crystalline silicate
- 3. The media shall be certified by the Manufacturer for use in the filter. The media shall be NSF Standard 50 listed
- 4. The media shall be Celaperl 1000 as supplied by EP Minerals
- 5. Each filter shall be furnished with six (6) charges of filter media

O. Warranty:

- 1. Filter tanks shall carry a ten (10) year fully rated warranty as regularly offered by the tank manufacturer
- 2. Bump tire and internal tube elements shall carry a fully rated ten (10) year warranty
- 3. Valve bodies shall carry a five (5) year fully rated warranty
- 4. Valve operators and system accessories including the RMF controller, quick exhaust valve, and solenoid valve shall carry one (1) year warranties as provided by the manufacturer

1.4 Cartridge Filter System

A. Approved Manufacturers

- 1. Pentair
- 2. Hayward

B. Cartridge Filter System shall include the following:

- 1. Filter Vessel
- 2. Chemical resistant tank body
- 3. High flow manual air relief valve
- 4. Unionized connections
- 5. Minimum one (1) replacement cartridge
- 6. Isolation valves for each filter vessel

7. Distribution Piping
- 1.5 PERMANENT MEDIA FILTERS
- A. Approved Manufacturers
 1. Rain Bird
 2. Approved Equal
 - B. Supply and install filter Auto flush mechanism and appropriate controls as recommended by manufacturer for the application.
 - C. Filters shall be sized to meet the filtering flow rates and fit spatially in the footprint provided shown on the Contract Documents
 - D. All controls and valving must be accessible for correct operation and regular maintenance as outlined in the manufacturer's Operation and Maintenance Manual
 - E. Maximum operating pressure of 150 PSI [10 bar].
 - F. Automatic Filter Control System:
 1. Filtered, clean water backwashing initiated automatically by time or pressure differential trigger
 2. Control system shall consist:
 - a. Programmable Logic Controller
 - b. Differential pressure switch
 - c. Electric drive motor
 - d. Solenoid actuated flush valve
 3. Controller shall continuously monitor and be capable of displaying the following:
 - a. Filter Inlet Pressure in psi (kPa)
 - b. Filter Outlet Pressure in psi (kPa)
 - c. Differential Pressure in psi (kPa)
 - G. Distribution Piping:
 1. Influent and effluent connections shall be sized as shown on the Contract Documents
 2. Influent and effluent pipes shall be fitted with Schedule 80 PVC flanged fittings with a minimum strength requirement of 1,500 lb-ft (207 kg-m) of bending moment and 200 lb-ft (28 kg-m) of torque
 - H. Materials of Construction:
 1. Fastening Hardware shall be 316L Stainless Steel
 2. Vessel, Housing and Covers to be powdercoated steel certified by MFG for operation in the design environment with no adverse effects for the duration of expected operational life.
 3. Screens material shall be 316L Stainless Steel
- 1.6 BACKWASH HOLDING TANKS AND SUMPS
- A. Backwash Holding Tanks
 1. Tanks shall be constructed of cast-in-place concrete per location and dimensions as indicated on the Contract Documents
 2. Tank walls and floor shall be water tight
 3. Tank floor shall slope to the drain
 4. Tank shall have an open top
 5. Provide a means of access into the tank by means of a fiberglass ladder inside the tank. For above grade tanks, provide a fiberglass ladder on the outside of the tank

- B. Backwash Sumps
 - 1. Acceptable Manufacturers
 - a. ASA Manufacturing Incorporated
 - b. Approved Equal
 - 2. Sumps shall be constructed of premium fiberglass and resin with a durable smooth gelcoat interior
 - 3. Include a heavy duty grate cover
 - 4. Drain pipe shall discharge from the bottom of the box. Side discharges may only be used as approved by the Engineer

PART 2 - EXECUTION**2.1 EXAMINATION**

- A. Examine surfaces, substrates, and conditions for compliance with requirements of other sections in which related Work is specified, and determine if surfaces, substrates, and conditions affecting performance of the Work of this section are satisfactory. Do not proceed with the Work of this section until unsatisfactory conditions have been corrected in a manner acceptable to the Installer. Starting installation constitutes acceptance of surfaces, substrates, and conditions

2.2 INSTALLATION

- A. Install filters in strict compliance with the Manufacturer's recommendations to insure the Manufacturer's warranty conditions can be met
- B. Locate filters in locations indicated on the Contract Documents, on smooth and level concrete housekeeping pads
- C. Inspect filters removing any dirt or foreign material from the Filter vessel and influent, effluent, and distribution piping
- D. Verify access to filter man ways, control panel, drains, and valves in accordance to the Manufacturer's recommendations
- E. Install appropriate amount of filter media in each Filter vessel in accordance to manufacturer's recommendations
- F. Assemble header piping and valves on site as indicated on the Contract Documents. Pipes may need to be trimmed in the field. Header piping shall be installed without springing or forcing, true to line and grade, and square with the filter system
- G. Mount filter control console in the location indicated on the Contract Documents
- H. Pipe drain from filter drain locations with Schedule 40 pipe to floor drain. Anchor drain pipe to unistrut supports and concrete floor as required
- I. Install backwash site glass in accordance with the Manufacturer's recommendation. Sight glass shall be installed in line so backwash flow from each vessel shall flow directly through the site glass.
- J. Pipe backwash effluent line to backwash holding tank or sump or to the sanitary sewer line connection

2.3 Backwash Holding Tank or Sump

- A. Provide a backwash holding tank or sump as indicated on the Contract Documents
- B. Tank or sump shall be sized to accommodate one (1) filter at a backwash rate of 25 gpm (95 lpm) per square foot (929 sq cm) of filter area for a minimum duration of five (5) minutes
- C. Backwash effluent lines from the filters shall discharge a minimum of 6 inches (150mm) above the top of the tank or sump and be located in a manner to prevent backwash water from splashing out

- D. Backwash tank or sump shall have a drain in the bottom connected to the sanitary sewer line. The line shall be sized to meet the flow requirements provided by the Civil Engineer

END OF SECTION

SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS

PART 1 - GENERAL**1.1 SUMMARY****A. This section includes the following:**

1. Chemical Test Kits
2. Erosion Feed System
3. Chlorinator Feed System
4. Chemical Metering Pump
5. Liquid Chlorine Feed System
6. Acid Feed System
7. Carbon Dioxide (CO₂) Feed System
8. Chemical Control Unit

B. Related Sections:

1. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
2. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
3. SECTION 13 1501 – WATER FEATURE MECHANICAL IDENTIFICATION
4. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
5. SECTION 13 1503 – WATER FEATURE FILTERS
6. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
7. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
8. SECTION 13 1507 – WATER FEATURE HEATERS
9. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
10. SECTION 13 1509 – WATER FEATURE CHILLERS
11. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
12. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
13. SECTION 13 1602 – WATER FEATURE CONTROLS
14. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS

1.2 SUBMITTALS FOR REVIEW**A. SECTION 01 3300 – SUBMITTAL PROCEDURES****B. Product Data:** Submit manufacturer's literature including printed recommendations, dimensions and sizes, and accessories for each system type.

1. Indicate on the submittal which materials, models, data, and options are being selected

C. Manufacturer's Certification: Submit documentation from the manufacturer certifying that the chemical systems conform with National Sanitation Foundation (NSF) Standard 50 guidelines**D. Operation and Maintenance Data:** Provide manufacturer's installation instructions, specifications, start-up procedures, assembly drawings, troubleshooting checklists, scheduled maintenance recommendations, replacement part lists and repair data**E. Warranty:** Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer.**1.3 QUALITY ASSURANCE****A. Manufacturer:** Company specializing in manufacturing products specified in this Section with a minimum five (5) years of documented experience**B. Installer Qualifications:** Company specializing in performing the Work of this Section with a minimum of five (5) years of documented experience

- C. Chemical Control System: Provide with on-site start-up, on-site operator training, and on-site warranty service, all of which shall be performed by a representative trained and authorized by the Manufacturer

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery with installation time to assure minimum holding time
- B. Accept chemical feed equipment and accessories on-site in original factory packaging. Immediately upon receipt of shipment, inspect, and check for damage
- C. Protect chemical feed equipment and accessories from physical damage including the effects of weather, water, and construction debris

PART 2 - PRODUCTS

2.1 CHEMICAL TEST KITS

- A. Acceptable Manufacturers
 - 1. Liquid Reagent Test Kits
 - a. Taylor: Professional Complete Chlorine Testing Lab
 - 2. Portable Digital Test Meters
 - a. Myron L Company: PoolPro PS9
- B. Liquid Reagent Test Kit:
 - 1. Furnish one (1) test kit containing liquid reagents enough for at least five (5) complete tests for each of the following parameters:
 - a. Bromine (1-10 ppm) or Chlorine (1-10 ppm). Both free and total measuring capabilities
 - b. pH, Acid and Base demand (6.8 – 8.4)
 - c. Total Alkalinity
 - d. Calcium Hardness
 - e. Cyanuric Acid
 - 2. Kit shall be provided in a portable molded plastic carrying case containing all reagents, comparators, waterproof instructions, and chemistry guide
- C. Portable Digital Test Meter
 - 1. Furnish one (1) accurate portable digital test meter capable of analyzing the following six (9) parameters with auto ranging and auto temperature compensation:
 - a. pH
 - b. Total Dissolved Solids (TDH)
 - c. ORP in millivolts (mV)
 - d. Alkalinity
 - e. Hardness
 - f. Langelier Saturation Index (LSI)
 - g. Temperature in °F and °C
 - h. Mineral / Salt
 - i. Conductivity
 - 2. Meter shall be direct reading, not colormetric or requiring reagents
 - 3. Meter shall be waterproof to 3 feet (1m) and buoyant
 - 4. Meter shall have a four (4) digit LCD display for full 9999 readings
 - 5. Meter shall log up to 100 readings with a date and time stamp and be capable of downloading test data, with optional docking port, to a computer for records and reporting
 - 6. Meter shall be factory calibrated to NIST Standards with certification available upon request

7. Furnish standard solution, minimum of 2 oz (59ml), for calibration of pH and conductivity, and for ORP and pH sensor storage

2.2 EROSION FEED SYSTEM

- A. Acceptable Manufacturers
 1. Rainbow Chlorinator
 2. Vantage
- B. Erosion Feed System shall be modular design and shall be supplied as one integrated package from a single source.
- C. Erosion Feed System shall consist of the following:
 1. Erosion Feeder / Chemical Storage Tank
 2. Solenoid Valve and Bypass Assembly
 3. Flow meter for each erosion feeder
 4. Inlet isolation valve for each erosion feeder
- D. Erosion Feeder / Chemical Storage Tank
 1. Number and size of feeder(s) as indicated on the Contract Documents and equipment schedules
 2. Constructed of fiberglass reinforced plastic (FRP) or molded plastic
 3. Tank Access: Tri-pin collar lid assembly
 4. Threaded inlet and outlet
- E. Solenoid Valve and Bypass Assembly
 1. Size as indicated on the Contract Documents
 2. Solid brass solenoid valve utilizing 120 VAC single phase power
 3. Two (2) manual isolation ball valves, one (1) on each side of the solenoid valve
 4. One (1) manual ball valve on bypass line
 5. Bypass line shall be constructed of Schedule 80 PVC pipe
- F. Flow Meter:
 1. Blue-White flow meter, F-300 or similar
 2. Size flow meter to pipe
 3. Flow Rate flow range from 0 to 30 gpm (0 to 113 lpm)
 4. Install flow meter in accordance with the Manufacturer's recommendations
- G. Both the inlet valve and calibrated outlet valve shall be as indicated on the Contract Documents

2.3 CHLORINATOR FEED SYSTEM

- A. Acceptable Manufacturers:
 1. PPG Industries – Accu-Tab System
 2. Vantage
- B. The system shall be designed to feed low concentrations of calcium hypochlorite in solution intermittently or continuously as required for the application.
- C. The system shall be a single pre-assembled, package unit with a welded aluminum frame consisting of the following:
 1. Chlorinator
 2. Electrical Box
 3. Centrifugal Pump
 4. Balance Tank
- D. System Features:

1. A maximum chlorine solution level of 0.05% (500 ppm) shall be maintained to prevent calcification in system components. System producing chlorine concentrations higher than 0.05% (500 ppm) shall not be acceptable
 2. Delivery shall be by erosion feed technology to control accurate and consistent concentration limits in the chlorine treatment solution. Soaking type, spray and/or vortex technology system shall not be acceptable
 3. The Chlorinator shall automatically and continuously feed a limited quantity of chlorine in solution as needed; when the system is not running, no more chlorine than that amount which can be fed in one (1) minute or less shall be left in the tank to prevent dilution. Batch systems preparing excess quantities of solution for delivery over an extended period shall not be acceptable
 4. A Centrifugal Pump wired to the system Electrical Box shall be feed freshly mixed chlorine treatment solution only as required for maximum efficiency. Batch systems requiring the use of a metering pump or pumps to feed prepared standing solution shall not be acceptable
 5. All piping in the Chlorinator unit shall be Schedule 40 PVC. Systems with flexible tubing shall not be acceptable
- E. Chlorinator Feed System consists of the following:
1. Solution Tank
 2. Primary Solution Tank Level Control
 3. Secondary High Level Solution Tank Control
 4. Solution Delivery Pump
 5. Accessories
- F. Solution Tank
1. Constructed of one piece heavy duty polyethylene or nalgene with UV stabilizer
 2. Translucent with molded calibrations on the tank
 3. Flat bottom design
 4. Tight sealing, rigid high-strength lids
 5. Capacity: as indicated on the Contract Documents and equipment schedules
- G. Primary Solution Tank Level Control
1. Made of Schedule 80 PVC and 316L stainless steel, this float valve meters the tablet bypass flow. The bypass stream balances the variations in the water-dissolving stream. The float opens or closes to maintain the pump rate it is manually throttled
- H. Secondary High Level Solution Tank Control
1. Prevents the solution tank from overflowing.
 2. High Level: when activated, a switch opens the circuit to the solenoid valve, causing the valve to close
- I. Accessories:
1. Inlet Water Supply Connection with Filter – as shown on the Contract Documents
 2. Inlet Solenoid Valve – Opens and closes on command when the system receives a signal, 110 VAC required
 3. Flow Meter – a rotometer (flow-through) flow meter, measuring the flow of the water-dissolving stream to the Chlorinator
 4. Flow Control Valve – PVC gate valve mounted in line with the flow meter allows operator to adjust flow of water-dissolving stream
 5. Solution Injection Pump Air Bleed – used to prime the pump at start-up, or at any time, if necessary
 6. Primary Backflow Prevention – PVC spring-assisted Wye-check valve prevents reverse flow of water into the system

7. Discharge Control Valve (manual) – used to balance system output water flow with system input water flow
8. Outlet Connection – as shown on the Contract Documents
9. NEMA 4X Electrical Enclosure – for pump and chemical controls
10. Aluminum Frame, Type 6061-T

2.4 CHEMICAL METERING PUMPS

A. Diaphragm Type Pump

1. Acceptable Manufacturers
 - a. LMI Milton Roy
 - b. PULSAtron
2. Housing of chemically resistant glass fiber reinforced thermoplastics
 - a. Fittings – PVDF
 - b. Seal Rings – Teflon, Viton (dependant on selected model)
 - c. Suction Tubing – Polyethylene
 - d. Diaphragms and Seals – Teflon
3. Materials that shall NOT be used: PVC, Acrylic, Stainless Steel, Ceramic, Vinyl, and Hypalon
4. All interior pump components, seats, valves, etc to be compatible with the solution it is pumping
5. Pump drive shall be totally enclosed with no moving parts
6. Electronics shall be housed in a chemical resistant enclosure
7. Check Valve: Teflon
8. Provide a Filter, Regulator, and Lubricator for each pump
9. Provide a foot valve with integral one piece strainer and enough polyethylene tubing with factory installed compression connections to run from the chemical storage tank to the pump, for each pump
10. Provide a wall mounting bracket composed of polypropylene and associated hardware for each pump
11. Metering pump shall incorporate a variable feed capability to adjust feed rates

B. Peristaltic Type Pumps

1. Acceptable Manufacturers
 - a. Stenner
2. NSF Standard 50 listing
3. Housing of polycarbonate plastic rated for indoor or outdoor use
4. Peristaltic Tube: Material appropriate to be in contact with liquid being pumped
5. Suction and Discharge Tubing: Material of construction appropriate to be in contact with chemicals being pumped
6. Electronics shall be housed in a chemical resistant enclosure
7. Suction Weight: Ceramic
8. Provide a foot valve with integral one piece strainer and enough polyethylene tubing with factory installed compression connections to run from the chemical storage tank to the pump, for each pump
9. Provide a wall mounting bracket composed of polypropylene and associated hardware for each pump
10. Metering pump shall incorporate a variable feed capability to adjust feed rates

2.5 LIQUID CHLORINE FEED SYSTEM

- A. Chlorine Feed System shall dose stored Liquid Sodium Hypochlorite solution of a concentration of 10% by the means of a Chemical Metering Pump, which is activated upon a signal from the Chemical Control Unit
- B. Chlorine Feed System consists of the following:
 - 1. Chemical Metering Pump
 - 2. Chlorine Storage Tank
 - 3. Containment Tank
- C. Chlorine Storage Tank
 - 1. Constructed of one piece heavy duty polyethylene or nalgene with UV stabilizer
 - 2. Translucent with molded calibrations on the tank
 - 3. Flat bottom design
 - 4. Tight sealing, rigid high-strength lids
 - 5. Capacity: as indicated on the Contract Documents and equipment schedules
 - 6. Tank shall be sufficiently anchored to the floor to resist vertical loads (seismic or wind)
- D. Containment Tank
 - 1. Constructed of one piece heavy duty polyethylene or nalgene with UV stabilizer
 - 2. Translucent with molded calibrations on the tank
 - 3. Flat bottom design
 - 4. Overall height shall be at least 2 inches (50mm) lower than the acid storage tank height
 - 5. Inside diameter shall be at least 4 inches (100mm) larger than the acid storage tank outside diameter
 - 6. Capacity shall be at least 10% larger than the acid storage tank
 - 7. Containment tanks may not be necessary if double-walled storage tanks are approved by local codes and regulations. Verify approval with the Owner's Representative and Engineer

2.6 ACID FEED SYSTEM

- A. Acid Feed System shall dose stored muriatic acid solution with a concentration of 32% by the means of a Chemical Metering Pump, which is activated upon a signal from the Chemical Control Unit
- B. Acid Feed System consists of the following:
 - 1. Chemical Metering Pump
 - 2. Acid Storage Tank
 - 3. Containment Tank
- C. Acid Storage Tank
 - 1. Constructed of one piece heavy duty polyethylene or nalgene with UV stabilizer
 - 2. Translucent with molded calibrations on the tank
 - 3. Flat bottom design
 - 4. Tight sealing, rigid high-strength lids
 - 5. Capacity: as indicated on the Contract Documents and equipment schedules
 - 6. Tank shall be sufficiently anchored to the floor to resist vertical loads (seismic or wind)
- D. Containment Tank
 - 1. Constructed of one piece heavy duty polyethylene or nalgene with UV stabilizer
 - 2. Translucent with molded calibrations on the tank
 - 3. Flat bottom design
 - 4. Overall height shall be at least 2 inches (50mm) lower than the acid storage tank height
 - 5. Inside diameter shall be at least 4 inches (100mm) larger than the acid storage tank outside diameter
 - 6. Capacity shall be at least 10% larger than the acid storage tank

7. Containment tanks may not be necessary if double-walled storage tanks are approved by local codes and regulations. Verify approval with the Owner's Representative and Engineer

2.7 CARBON DIOXIDE (CO₂) FEED SYSTEMS

A. Acceptable Manufacturers

1. Taylor-Wharton
2. Vantage

B. CO₂ System shall be modular design and shall be supplied as one integral package from a single source. System shall consists of the following:

1. Bulk Storage Tank(s)
2. Interconnecting Hardware
3. Feed Control Unit
4. Solenoid Valve
5. Injection Diffuser
6. Remote Fill Line with pressure relief valve

C. Bulk Storage Tank

1. Stainless Steel, Double-walled, vacuum-jacketed vessel
2. Inner tank of stainless steel wrapped with insulation
3. Stainless steel shroud to protect valves and gauges
4. Minimum usage rate of 3.2 lb (1.4 kg) per day and maximum continuous gaseous flow rate of 20 lbs (9.0 kg) per hour
5. Include a pressure building system with a 7.5 amp / 120 volt heater extending into liquid CO₂ in tank
6. Provided with:
 - a. Gas-use regulator
 - b. Safety Relief Valve
 - c. Burst Disc
 - d. No-loss single hose fill system

D. Provide a venturi fill system that works by collapsing tank head pressure during filling to allow tank to be filled from 1/3 full to full without venting any CO₂

E. Fill tank through an exterior, wall-mounted fill station at a rate of 30 to 50 lbs (13.6 to 22.7 kg) per minute

F. Filling Operation: Fully automatic and capable of being complete without entering the building

G. Fill Box: Includes a quick-disconnect, automatic closing coupling and a lockable door

H. Provide an adjustable feed unit with a maximum feed rate of 200 SCFH (5.6 CMH)

I. Supply CO₂ from storage tank to wall-mounted feed unit through thick-wall 3/8 inch (10mm) outside diameter polyethylene tubing

J. Feed System includes the following:

1. Includes a 120V solenoid operated valve for remote on / off control of CO₂ feed
2. CO₂ feed unit shall also include rate adjusting flow meter scaled from 20-200 SCFH (0.56 to 5.6 CMH) and have a pressure rating of 100 psi (689 kPa)

K. Diffuser/Injection Fitting

1. Inject CO₂ from feed unit through a ½ inch (15mm) NPT diffuser/injection fitting
2. Totally diffuse CO₂ into solution without evidence of CO₂ bubbling at any point where water is open to atmosphere
3. Equip unit with a spring check valve to prevent backflow of water into feed unit

2.8 Chemical Control Unit

- A. Acceptable Manufacturers
 1. BECS Technology
 2. Chemtrol by Santa Barbara Control Systems
 3. Strantrol by Siemens Water Technology
 4. CAT Controllers, Incorporated
- B. Chemical Control Unit shall be modular design and shall be supplied as one integrated package from a single source. Control Unit consists of the following:
 1. Chemical Control Unit model as indicated on the Contract Documents equipment schedules
 2. Flow Cell and Sensor Assembly with Industrial Grade Probes
 3. Automatic Probe Rinse
- C. Chemical Control Unit
 1. Integrated microprocessor-based electronic water treatment control system to continuously monitor water chemistry and for automatic control of the chemical feed systems
 2. Housing shall be a NEMA Type 3 lockable fiberglass cabinet with a visible LCD graphic display and accessible touch pad for direct access to all menus, sub-menus, and for entering numerical data
 3. The following parameters shall be continuously monitored and displayed in the LCD graphic display:
 - a. Display Range and Accuracy
 - i. pH Level: 1.0 to 9.95 with a resolution of 0.01 units
 - ii. ORP Level: 0 to 1000 mV with a resolution of 1 mV
 - iii. Sanitizer Residual: 0 to 20 ppm with a resolution of 0.1 ppm
 - iv. Total Dissolved Solids (TDS): 1 to 1000 ppm with a resolution of 1 ppm
 - v. Temperature: 32 to 120 °F (0 to 50 °C) with a resolution of 0.01 °F
 4. Modes of operation shall include: OFF, Manual, Automatic, and Timer Cycle
 5. In Manual Mode the Controller shall:
 - a. Allow the Operator access to all outputs to chemical feeders, heaters, cleaners, and controller accessories
 - b. Allow operator access to all alarms and controls
 6. In Automatic and Timer Cycle Mode the Controller shall:
 - a. Automatically activate the appropriate chemical feeders in order to maintain pH, ORP, and sanitizer set point values within the following tolerances:
 - i. pH within +/- 0.1 pH unit
 - ii. ORP within +/- 10 mV
 - iii. Sanitizer Residual within +/- 0.1 ppm
 - iv. Heater within +/- 2.0 °F
 - b. Be able to operate in either standard on / off feed control or proportional feed control with adjustable dead band and progressive control zones
 - c. Monitor all alarm conditions
 - d. Automatically clean and rinse probes on an adjustable seven (7) day program
 - e. Capable of being programmed for four (4) separate timed events, each having independent daily on and off settings
 7. Visible indicator lights shall activate when pH and ORP and/or Sanitizer chemicals are being fed and the heater is operating
 8. All set point and calibration levels shall be operator adjustable with the numeric keypad on the unit
 9. Controller alarms shall include:

- a. Visible high and low level alarms for pH, ORP and/or Sanitizer, and temperature with optional feed lockouts and alarm buzzer options
 - b. Continuous monitoring for failure of pH and ORP and/or Sanitizer probes using dynamic probe testing and alert if failure occurs before water chemistry gets out of range
 - c. A low flow warning message to alert the Operator when a low or no flow condition exists. Should a low or no flow condition exist, the system shall disable all chemical feed functions
10. Controller shall have a broad memory capable of logging up to 68 days with frequency of logged input points shall be adjustable from every minute for every four (4) hours and shall record data on the following:
 - a. pH and ORP and/or Sanitizer readings
 - b. Any alarm conditions
 - c. Any set point adjustments and feed event history
11. Controller shall include a memory storage battery with a minimum reserve power for six (6) months
- D. Flow Cell and Sensor
 1. Control System shall include a remote mounted flow cell and sensor assembly enclosed in a non-corrosive, lockable fiberglass enclosure with a window
 2. Incorporate the following features:
 - a. An integral self-air purging sensing chamber with see-through inspection cover and two sensing electrodes
 - b. A paddle wheel-style flow switch with see-through cover and "on stream" light
 - c. Flow switch shall indicate flow through sample stream and signal controller to initiate an alarm condition and to shut off feed circuits in event flow should stop
 - d. Flow switch shall operate on low voltage and be made of non-corrosive material
 - e. Valves for isolating all assembly components and a water sample test valve shall be provided and be constructed entirely of non-corrosive materials
 - f. ORP sensing electrode shall incorporate at least one (1) square centimeter of 99.999% pure platinum
 - g. Both electrodes shall contain not less than 50 milliliters of electrolyte gel to lengthen electrode life
 - h. Gel used in each electrode shall be inorganic so as to prevent degradation by chlorine or bromine
 - i. Each electrode shall use a porous Teflon liquid junction to minimize the chance of liquid junction clogging and prolong electrode life
 - j. Electrodes utilizing organic gels or wood or ceramic liquid conjunctions are considered equal to these specifications
- E. Automatic Probe Rinse
 1. An automatic probe rinse system to clean sensing probes shall be provided
 2. System shall consist of one (1) six gallon (22 liter) vapor-proof tank, one (1) feed pump capable of pumping up to 10 gallons per day (757 liters per day) at 75 psi (517 kPa) and a four (4) function anti-siphon/pressure relief valve
 3. Feed pump shall be controlled by a digital programmable electronic timer in the controller

PART 3 - EXECUTION

3.1 GENERAL

- A. Supply all labor, equipment, and materials to construct, test and put into operation complete system lines, valves, tanks, and injectors in accordance with the Contract Documents and as directed by the Engineer of Record
- B. Install all piping without bending, springing or forcing, true to line and grade, in a neat and workman like manner and properly supported
- C. Install tubing in adequate lengths so equipment can be moved or adjusted in positions and locations for maintenance purposes without disconnecting tubing
- D. Inspect all equipment and remove any dirt or foreign material before attaching inlet, outlet piping or tubing
- E. Injectors shall tap into filtered water return lines and shall incorporate shutoff valves to allow disconnection of feed lines while filters are operating
- F. Install the entire systems to meet applicable state and local codes, including but not limited to NSF guidelines

3.2 INSTALLATION

- A. Erosion Feed System
 - 1. Locate Erosion Feeders in locations indicated on the Contract Documents, on smooth and level concrete housekeeping pads
 - 2. Install valves, meter injectors, and piping as indicated on the Contract Documents. Located all equipment, valves, meters, and injectors so they are easily accessible and meters can be easily read
 - 3. Install solenoid and bypass assembly as indicated on the Contract Documents. Connect control line from Chemical Control Unit to solenoid valve to allow chemical feed upon signal from chemical controller
- B. Chlorinator Feed System
 - 1. Locate Chlorinator System in locations indicated on the Contract Documents, on smooth and level concrete housekeeping pads
 - 2. Chlorinator System shall be provided as a skid mount type package. The Contractor shall provide plumbing and electrical connections
 - 3. The Chlorinator influent line shall tee off the main line after the filter and before the heater. The Chlorinator effluent line shall tee back in to the main line after the heater.
- C. Liquid Chemical Feed Systems
 - 1. Locate Liquid Chemical Feed (Liquid Chlorine and/or Acid) Systems in locations indicated on the Contract Documents.
 - 2. Provide a 4 inch (100mm) wide by 6 inch (150mm) tall containment curb surrounding the chemical storage tanks. Curb shall provide spill containment. Do not allow liquid chlorine and acid storage tanks to be placed within the same containment curbed area
 - 3. Mount chemical metering pump in the locations shown on the Contract Documents, approximately 48 inches (1.2m) above the finished floor elevation and to the side of each tank. Do not mount the pump directly above the chemical tanks
 - 4. Upon delivery of the chemical storage tanks, inspect for defects or shipping damage. Any discrepancies, or product problems, should be noted on both the driver's bill of landing and the Contractor's packing list
 - 5. When unloading tank(s) from the delivery truck, avoid contact with sharp objects
 - 6. Do not allow tank(s) to be rolled over on the fittings. Large bulk storage tank(s), whenever possible, should be removed from the delivery truck bed by use of a crane or other suitable lifting device
 - 7. Keep unloading area free of rocks, sharp objects, and other materials that could damage the tank

8. If tank(s) are unload on their side, carefully brace to prevent rolling
 9. Test by filling the tank(s) with water prior to use, to prevent chemical loss through unsecured fittings, shipping damage, or manufacturing defects. Tanks should be tested for a minimum of five (5) hours
 10. Do not mount heavy equipment on tank sides
 11. Do not allow weight on tank fittings. Fully support pipes and valves connected to tanks
 12. Supply enough liquid chemicals to fill the tank(s) to a level within 3 inches (75mm) from the top of tank(s)
- D. CO₂ Feed System
1. Locate bulk storage tanks in locations indicated on the Contract Documents on smooth and level concrete housekeeping pads
 2. Install system in accordance with manufacturer's recommendations
 3. Remote fill system shall be installed in accessible area for refilling
 4. Install tubing in ½ inch (15mm) PVC sleeves properly supported and anchored
 5. All equipment shall be installed in accessible locations
 6. Supply enough Liquid CO₂ to fill all of the tanks
- E. Chemical Control Unit
1. Mount the Chemical Control Unit on the wall in the general location as indicated on the Contract Documents and where the controller, probes, and automatic rinse unit may be easily accessible
 2. Install isolation valves on the influent and effluent sides of the probe housing.
 3. Factory Representative shall be on site to calibrate and perform initial start-up of the chemical controller. Calibration should be performed testing water at the control unit using the sampling valve and comparing this sample with several samples taken from the pool, one from the edge of the pool and one from the center of the pool a minimum of 18 inches (450mm) below water level. No samples should be taken from the surface of the pool
 4. Supply enough cleaning solution to fill probe rinse tank
 5. Provide a phone line or wireless connection near the chemical controller.
 6. If a printer has been provided, install the printer on a wall shelf in a location where it will be protected from moisture and water spray and is easily accessible

END OF SECTION

SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Ozone Generation Systems including Safety Interlocks and Controls
 - 2. Air Preparation and Oxygen Concentration Systems
 - 3. Ozone Injections and Contacting Systems
 - 4. Ozone Degassing and Destruct Systems
 - 5. Ambient Ozone Monitoring and Alarms
- B. Related Sections:
 - 1. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
 - 2. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
 - 3. SECTION 13 1501 – WATER FEATURE MECHANICAL IDENTIFICATION
 - 4. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 5. SECTION 13 1503 – WATER FEATURE FILTERS
 - 6. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 7. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
 - 8. SECTION 13 1507 – WATER FEATURE HEATERS
 - 9. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
 - 10. SECTION 13 1509 – WATER FEATURE CHILLERS
 - 11. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
 - 12. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
 - 13. SECTION 13 1602 – WATER FEATURE CONTROLS
 - 14. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit manufacturer's literature including printed recommendations, dimensions and sizes for Ozone Generator, Air Preparation System, Injection and Contacting Components, Degas Valves, Destruct Units, Ambient Monitor, and accessories.
 - 1. Indicate on each submittal which materials, models, data, and options are being selected
- C. Manufacturer's Certification: Submit documentation from the Manufacturer certifying that the Ozone System, including all components, conform with the National Sanitation Foundation (NSF) Standard 50 guidelines
- D. Operation and Maintenance Data: Provide the Manufacturer's installation instructions, specifications, start-up procedures, assembly drawings, troubleshooting checklists, schedule maintenance recommendations, and replacement part lists and repair data
- E. Warranty: Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery with installation time to assure minimum holding time
- B. Accept Ozone Generator, Air Preparation System, Injection and Contacting System, Degas and Destruct Units, and Monitors and accessories on site in original factory packaging. Immediately upon receipt of shipment, inspect and check for damage

- C. Protect Ozone Generator, Air Preparation System, Injection and Contacting System, Degas and Destruct Units, and Monitors and accessories from physical damage including effects of weather, water, and construction debris

PART 2 - PRODUCTS**2.1 Overall Ozone System**

- A. Manufacturers
 - 1. DEL Industries
- B. An Ozone System shall consist of a modular package incorporating the following components:
 - 1. Ozone Generator
 - 2. Air Preparation Components
 - a. Oxygen Concentrator
 - b. Air Compressor
 - 3. Injector and Bypass Assembly
 - 4. Mixing/Reaction/Degassing Tank
 - 5. Degas Valve
 - 6. Off-gas Destruct Unit
 - 7. Ambient Ozone Monitor
 - 8. Ambient Ozone Alarm Strobe Light
- C. Materials:
 - 1. Valves and Fittings for the purpose of ozone gas conveyance shall be Type 316L Stainless Steel
 - 2. Tubing and pipe for ozone gas conveyance shall be Type 316L Stainless Steel or Teflon™
 - 3. Seals, gaskets, O Rings, etc for ozone gas conveyance to be Teflon™ or Aflas™
 - 4. All exposed hardware and fasteners to be 316L Stainless Steel
- D. The System shall provide for complete ozone isolation during shutdown
- E. The Ozone Generator and components shall be NSF Standard 50 listed for safety and performance standards

2.2 OZONE GENERATOR

- A. The Ozone Generator shall be of the corona discharge type, producing ozone at high concentrations (greater than 5.0% by weight) to provide efficiency of operation and enhance mass transfer to the process water. No Ultraviolet (UV) ozone generation systems will be allowed
- B. Ozone shall be generated and maintained under vacuum until the point of injection into the process water and is to be kept under vacuum at all times.
 - 1. Pressurized ozone systems will not be allowed
 - 2. Partial loss of vacuum shall be compensated for by automatic feed gas flow reduction
 - 3. Critical vacuum loss shall cause a system fault and initiate system shutdown
- C. Generator module shall be all 316L Stainless Steel, glass, and ceramic construction. No Generators utilizing combustible materials or ozone affected materials shall be allowed
- D. Each Ozone Generator module shall be water cooled, utilizing a vertical tube in shell cooling design
- E. Electrodes shall be gas filled glass tubes providing individualized fusing for power supply protection
- F. Ozone Generator shall permit variable production within a range of 0 to 100% of rated output
- G. Power requirements of the ozone generation (not including oxygen system) shall not exceed 20.0 Watts per gram of ozone produced per hour

- H. Ozone Generator shall be controlled by an internal Programmable Logic Controller (PLC), to automatically control start-up and shutdown sequencing, fault protections, ORP control, oxygen concentrator feed gas operation, and remote start/stop
- I. The generator shall be capable of continuous operation for one (1) year with no major cleaning or disassembly

2.3 CONTROLS AND SAFETY INTERLOCKS

- A. All control circuitry shall be powered by a Class B low voltage power supply or GFCI protected and powered through an isolating step-down transformer
- B. Each Ozone Generator shall be furnished as a package which shall include the following safety controls fully interlocked through the PLC:
 - 1. Door safety switch(s)
 - 2. External emergency shutoff button
 - 3. Loss of Vacuum
 - 4. Low Feed Gas Pressure
 - 5. Low Oxygen Concentration
 - 6. Water Backflow Detection
 - 7. Thermal protection on high voltage transformer and generator module
 - 8. Standby Mode control function
 - 9. Phase Loss Detection/Protection
- C. Each Ozone Generator shall be further furnished with the following external/remote control and monitoring circuitry interfaced through the PLC:
 - 1. Ambient Ozone Monitor interlocked to the Ozone Generator shutdown and an Alarm
 - 2. System ON/OFF
 - 3. Emergency Stop
 - 4. System Fault Alarm Conditions
 - 5. Normal System Operation indications
- D. The PLC shall use low voltage DC circuitry for all sensor inputs
- E. The PLC shall store run time, settings and historic information on system events in non-volatile memory for retrieval by service personnel for diagnostic and troubleshooting purposes
- F. The PLC shall display text messages or diagnostic indicators controlled by the PLC indicating the cause of any fault event such as: Water Backflow, Door Open, Overheating, Low Feed Gas Pressure, Loss of Vacuum, etc
- G. Each Ozone Generator shall be provided with circuitry to permit deactivation from either the local control panel or from a remote location
- H. Each Ozone Generator shall provide input circuitry for connection of a remote monitoring/alarm equipment and output circuitry to indicate normal operation and abnormal system fault conditions to an external monitoring system
- I. Water backflow protection shall be provided within the Ozone Generator enclosure. The device shall be interlocked with the Ozone Generator's PLC initiating system fault shutdown and isolating the Generator to prevent damage by water ingress to the generator module

2.4 AIR PREPARATION COMPONENTS

- A. Oxygen Concentrator
 - 1. Oxygen Concentrator(s) shall be incorporated to automatically supply low pressure, 0-15 psig (0-103 kPa), oxygen rich feed gas to the Ozone Generator(s) at the required flow rate

2. Oxygen Concentrators shall be capable of supplying oxygen, at the rated flow rate (or higher), to the Ozone Generator(s) at a minimum of 85% purity and less than -60 °C dew point
 3. Approved Manufacturer for external Oxygen Concentrators: AirSep Corporation
- B. Air Compressor
1. Low output systems shall incorporate small oil-less compressor(s) housed within the Ozone Generator enclosure to supply each modular Oxygen Concentrator(s) housed within the same enclosure
 2. The Air Compressor packages for larger systems requiring external Air Preparation components shall include the following:
 - a. Air Compressor, rotary screw type, sized for 130% or more of the required feed of the Oxygen Concentrator
 - b. Post Chiller
 - c. Refrigerated Air Dryer
 - d. Air Receiver Tank with over-pressure protection and an automatic condensate drain valve
 - e. Filtration to remove oil, oil vapor, and any particulates larger than 0.1 micron
 - f. Condensate management system for separation and disposal of compressor oil carryover
 3. Approved Manufacturer for external Air Compressors: Kaesar Compressors, or approved equal
- 2.5 INJECTION SYSTEM AND BYPASS
- A. Introduction of ozone to the process water shall be via side-stream method incorporating venturi driven suction
 - B. Approved Manufacturer: Mazzei Injector Corporation
 - C. Venturi Injector shall be manufactured of Kynar™ for resistance to oxidation by ozone
 - D. Venturi Injector(s) shall be sized to provide a total suction rate 1.3 to 1.5 times the total rate of ozone gas flow from the Ozone Generator(s) in order to develop the necessary negative pressure within the Generator and ozone conveyance lines
 - E. Venturi Injector(s) shall further be sized with a liquid to gas ratio (V_L/V_G) of 0.05 or less and an outlet pressure of at least 15 psi (103 kPa) to assure efficient mass transfer
 - F. Each Venturi Injector shall be furnished with stainless steel fittings to adapt to ozone conveyance tubing and will include a stainless steel ball valve and check valve with appropriate seal materials as described in 2.1.C
- 2.6 MIXING/CONTACT/DEGASSING TANK
- A. The Contact Vessel shall be constructed of fiberglass reinforced plastic (FRP) with ozone resistant epoxy based vinyl ester resin interior coat
 - B. The Vessel must be NSF 50 listed
 - C. The Vessel must be rated for 50 psi (344 kPa) minimum working pressure
 - D. The Vessel shall be vertically mounted
 - E. Internal baffles shall be incorporated to eliminate short circuit flow through the Vessel
 - F. Plumbing Connections: Inlet and Outlet fittings shall be sized as shown on the Contract Documents or to limit flow velocity to less than 6 feet per second (1.83 m/s)
 - G. A Degas fitting shall be incorporated in the top of the Vessel for connection to the Degas Valve
 - H. Vessel drain fitting shall be 1-1/2 to 2 inches (40 to 50mm) minimum and be fitted with a ball valve accessible for maintenance

- I. All fastening hardware on flanges, man ways, and viewing port shall be 316L Stainless Steel
- 2.7 OZONE DEGAS VALVE
 - A. A Degas Valve shall be incorporated and fitted to the top of the Contact Tank for the purpose of automatically venting of undissolved, ozone-containing gases from the tank and directing them to the Ozone Destruct Unit
 - B. The Degas Valve body shall be constructed of PVC and ozone resistant materials used for valve seat, float, and mechanism
 - C. All fastening hardware shall be 316L Stainless Steel
- 2.8 CATALYTIC OZONE DESTRUCT UNIT
 - A. The Ozone Destruct Unit shall incorporate a preheated dry bed catalyst to remove greater than 99.5% of the ozone content from the off-gas
 - B. Low power heater shall be incorporated to preheat saturated off-gas to above the dewpoint to prevent condensation, protecting the metal oxide catalyst bed from moisture contamination
 - C. The Destruct Unit shall be constructed of 304 or 316 stainless steel with inlet fitting appropriate for connection to the Degas Valve
 - D. The Destruct Unit shall be sized to handle the full ozone production capacity of the system
 - E. The Destruct Unit shall incorporate minor demisting capability and automatic drain valve for condensate build-up
 - F. All fastening hardware shall be 316L Stainless Steel
- 2.9 AMBIENT OZONE MONITOR
 - A. Shall measure the level of ozone present in the room housing the ozone equipment, and shall shutdown the Ozone Generator when the ozone level exceeds a warning level of 0.1 ppm and a high alarm of 0.3 ppm
 - B. The Monitor shall have a range of 0-10 ppm by volume with an accuracy within 3% of actual
 - C. The Monitor shall employ an electrochemical gas diffusion sensor requiring no expendable reagents
- 2.10 AMBIENT OZONE ALARM INDICATOR STROBE LIGHT
 - A. Manufacturer: Edwards, N. 49R-N5 or approved equal
 - B. Strobe Color: Red
 - C. Nominal VA Rating: 25 Watts
 - D. Voltage: 120 VAC, 0.22 Amps
 - E. Mounting: Standard 4 inch (100mm) octagon (indoor only) electrical box
 - F. Alarm strobe shall illuminate on activation of Ambient Ozone Alarm and shall remain on until reset at the Ambient Ozone Monitor

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Examine surfaces, substrates, and conditions for compliance with requirements of other sections that relate to the Work specified. Determine if surfaces, substrates, and conditions affecting the performance of the Work of this section are satisfactory. Do not proceed with the Work of this section until unsatisfactory conditions have been corrected in a manner acceptable to the Installer. Starting installation constitutes acceptance of surfaces, substrates, and conditions

- B. Each system shall be capable of fitting into the space shown on the Contract Documents
- C. The Manufacturer shall supply a standard installation kit, which includes any necessary accessories and fittings for installation
- D. Provide complete installation instructions, and operations and maintenance manual with troubleshooting guide for each system

3.2 INSTALLATION

- A. The entire system shall be designed and installed to meet all applicable State and local codes
- B. Nationally recognized standards, as applicable, shall be adhered to
- C. Equipment enclosure shall be firmly attached to the flooring by lagging it into the concrete slab or housekeeping pad through holes provided according to instructions provided by the Manufacturer
- D. Install the Ozone Generator according to instructions provided by the Manufacturer
- E. All equipment, piping, meters, and appurtenances shall be to the Manufacturer's specification
- F. Leave sufficient space between equipment and pipes to allow for maintenance, replacement, and inspection
- G. Valves, pipe labels, meters, and displays must be visible and have sufficient space to access, if applicable
- H. Install ORP probe and controller as specified by the Manufacturer
- I. The Ozone Destruct Unit shall be installed at an elevation that is higher than the Degas Valve to prevent the possible flow of water into the Ozone Destruct Unit
- J. All Installer supplied fasteners and hardware shall be 316L Stainless Steel

3.3 FIELD OPERATION AND START-UP

- A. In the event of remote or local start, the Ozone Generator shall first be purged with dry oxygen from the feed gas system, then ramp up voltage to determined levels
- B. In the event of remote or local stop including reaching high ORP the Generator will initiate shutdown and purge with dry oxygen from the feed gas system before complete shutdown and isolation.
- C. Upon any system fault the Generator shall automatically and immediately cease ozone production and purge with dry oxygen from the feed gas system before complete shutdown and isolation. Manual acknowledgement and re-start shall be required
- D. A factory trained representative shall be on site for start-up of the system and training of operation personnel

END OF SECTION

SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS**PART 1 - GENERAL****1.1 SUMMARY****A. This section includes the following:**

1. Furnishing and Installing Valves and Flow Control Devices
2. Furnishing and Installing Gauges and Meters
3. Furnishing and Installing Thermometers and Temperature Probes
4. Furnishing and Installing Valve Actuators
5. Furnishing and Installing Accessories

B. Related Sections:

1. SECTION 13 1401 – WATER FEATURE PIPE AND FITTINGS
2. SECTION 13 1403 – WATER FEATURE PIPE HANGERS, SUPPORTS, AND ANCHORS
3. SECTION 13 1501 – WATER FEATURE MECHANICAL IDENTIFICATION
4. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
5. SECTION 13 1503 – WATER FEATURE FILTERS
6. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
7. SECTION 13 1507 – WATER FEATURE HEATERS
8. SECTION 13 1602 – WATER FEATURE CONTROLS
9. SECTION 13 1604 – WATER FEATURE FIELD INSTRUMENTS, SWITCHES, AND ALARMS

C. References:

1. ASTM D1784 – STANDARD SPECIFICATION FOR RIGID POLY(VINYL CHLORIDE) (PVC) COMPOUNDS AND CHLORINATED POLY(VINYL CHLORIDE) (CPVC) COMPOUNDS
2. ASTM F1030 – STANDARD PRACTICE FOR SELECTION OF VALVE OPERATORS
3. ASTM F1970 – STANDARD SPECIFICATION FOR SPECIAL ENGINEERED FITTINGS, APPURTENANCES OR VALVES FOR USE IN POLY (VINYL CHLORIDE) (PVC) OR CHLORINATED POLY (VINYL CHLORIDE) (CPVC) SYSTEMS
4. AMERICAN WATER WORKS ASSOCIATION (AWWA) C508-09 – SWING-CHECK VALVES FOR WATERWORKS SERVICE 2-IN THROUGH 24-IN (50-mm THROUGH 600-mm) NPS
5. AWWA C509-09 – RESILIENT-SEATED GATE VALVES FOR WATER SUPPLY SERVICE

1.2 SUBMITTALS FOR REVIEW**A. SECTION 01 3300 – SUBMITTAL PROCEDURES**

- B. Product Data:** Submit Manufacturer's literature including printed recommendations, compliance with Standard and Testing agencies, dimensions and sizes for all Valves, Gauges, Meters, and accessories.

1. Indicate on each submittal which materials, models, data, ratings, and options are being selected
 - C. Project Record Documents: Record actual horizontal and vertical locations of fittings, valves, and accessories on all site piping
 - D. Maintenance data for Valves, Gauges, Meters, and accessories including detailed instructions on adjusting, servicing, disassembling, and repairing. The Contractor shall provide the information neatly bound with the Manufacturer's literature
- 1.3 QUALITY ASSURANCE
- A. Comply with referenced Standards and Manufacturer's recommendations

PART 2 - PRODUCTS

2.1 VALVES AND FLOW CONTROL DEVICES

- A. Ball Valves
 1. Acceptable Manufacturers
 - a. Asahi/America
 - b. Hayward Industrial Plastics
 - c. Spears Manufacturing
 2. Ball Valves ¼ inch (6mm) and larger, body construction shall be one piece thermoplastic PVC conforming to Cell Classification 12454
 3. Seats shall be PTFE with elastomeric backing cushions the same material as all other "O" rings
 4. Ball Valves shall be True Union or double entry type with blocking capability
 5. Ball Valves shall have bubble tight shut-off with the following pressure ratings based on ambient temperature:
 - a. Sizes up to 3 inch (80mm): 230 psi (1.6 MPa)
 - b. Size 4 inch (100mm): 150 psi (1.0 MPa)
 6. Seals composed of Viton® or EPDM
 7. All Ball Valves shall be tested by the Manufacturer prior to shipment. Test documents shall be available upon request
- B. Butterfly Valves
 1. Acceptable Manufacturers
 - a. Asahi/America
 - b. Hayward Industrial Plastics
 - c. Spears Manufacturing
 2. Valve Disc shall be PVC or Polypropylene
 3. Stem shall be 316L Stainless Steel non-wetted type
 4. Metallic fasteners shall be 316L Stainless Steel
 5. External metallic trim shall be 300 series Stainless Steel epoxy or powder coated
 6. Seals: Full Seat Design, Isolating Stem from media and functioning as a gasket for mating flanges.

- a. Materials shall be Viton® or EPDM
 - 7. Butterfly Valve body materials for Underground or Above Ground Applications shall be as follows:
 - a. Sizes up to 14 inch (350mm) – shall be one piece thermoplastic PVC conforming to Cell Classification 12454. Body type shall be wafer type conforming to ANSI B16.5 Bolt Circle
 - b. Sizes 16 to 24 inch (400 to 600mm) – shall be one piece thermoplastic PVC conforming to Cell Classification 12454 or Polypropylene Cell Classification PP0210B67272. Body type shall be wafer type conforming to ANSI B16.5 Bolt Circle
 - 8. Butterfly Valve body materials for Submerged conditions shall be as follows:
 - a. Sizes up to 24 inch (600mm) – Valves shall meet requirements shown for Underground or Above Ground Applications with the following exceptions:
 - i. Valve Stems shall be 316L Stainless Steel for Fresh Water application and Titanium for Salt Water applications
 - ii. Stem extensions or 2 inch (50mm) square operating nuts of the appropriate material and design shall be supplied, subject to review of the installation and valve Manufacturer's recommendations
 - 9. Butterfly Valves shall be bubble tight shut-off with the following pressure ratings based on ambient temperature:
 - a. Sizes up to 10 inch (250mm): 150 psi (1.0 MPa)
 - b. Sizes 12 to 14 inch (300 to 450mm): 100 psi (690 kPa)
 - c. Size 16 inch (400mm): 85 psi (590 kPa)
 - d. Sizes 18 to 24 inch (450 to 600mm): 75 psi (520 kPa)
 - 10. Butterfly Valves 4 inches (100mm) and smaller shall be lever type with an internal locking device
 - 11. Butterfly Valves 6 inches (150mm) and larger shall be gear type. Gear operators shall be worm gear design with visual position indicator and travel stops
 - 12. Butterfly Valves located 7 feet (2m) or higher above finished floor elevation shall be provided with chain operators with the chain extending no more than 7 feet (2m) above the finished floor elevation
 - 13. All Butterfly Valves shall be tested by the Manufacturer prior to shipment. Test documents shall be available upon request
- C. Check Valves
- 1. Ball Check Valve
 - a. Acceptable Manufacturers
 - i. Asahi/America
 - ii. Hayward Industrial Plastics
 - iii. Spears Manufacturing

- b. Ball Check Valves shall be PVC, CPVC, PP or PVDF body with EPDM, FKM, or PTFE seals for valve sizes ½ to 4 inch (15 to 100mm)
 - c. Valves body construction shall be one piece thermoplastic construction
 - d. Valves shall be designed with an elastomeric uniseat/seal for tight shut-off under pressure
 - e. Sizes ½ to 2 inch (15 to 50mm) shall be True Union and sizes 3 to 4 inch (80 to 100mm) shall be single union
 - f. For sizes larger than 4 inch (100mm) material shall be epoxy or powder coated cast iron with flange connections meeting ANSI B16.5 bolt pattern
2. Swing Check Valve
- a. Acceptable Manufacturers
 - i. Asahi/America
 - ii. Hayward Industrial Plastics
 - iii. Spears Manufacturing
 - b. Swing Check Valves shall be PVC, PP, or PVDF body with FKM, EPDM, or PTFE seals and shall incorporate a single disc design suitable for horizontal or vertical applications
 - c. Valves shall have a top entry bonnet for maintenance purposes
 - d. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for 150 psi (1.0 MPa)
 - e. Swing Check Valves shall have the following pressure rating based on ambient temperature:
 - i. Elastomeric Seals:
 - 1. Sizes ¾ to 3 inch (20 to 80mm): 150 psi (1.0 MPa)
 - 2. Sizes 4 to 6 inch (100 to 150mm): 100 psi (689 kPa)
 - 3. Size 8 inch (200mm): 75 psi (571 kPa)
 - ii. PTFE Seals:
 - 1. Sizes ¾ to 2-1/2 inch (20 to 65mm): 90 psi (621 kPa)
 - 2. Sizes 3 to 4 inch (80 to 100mm): 75 psi (571 kPa)
 - 3. Size 5 inch (125mm): 60 psi (414 kPa)
 - 4. Sizes 6 to 8 inch (150 to 200mm): 45 psi (310 kPa)
3. Wafer Check Valve
- a. Metal Wafer Check Valve
 - i. Acceptable Manufacturers
 - 1. Ritepro Corporation
 - 2. APCO
 - ii. Wafer Check body construction shall be as follows:
 - 1. Valve Class 125: Cast Iron
 - 2. Valve Class 150: Ductile Iron
 - 3. Valve Class 300: Steel

- iii. Wafer Check Seating Material and Spacer Material
 - 1. Valve Class 125: Buna N and Teflon
 - 2. Valve Class 150: EPDM and Teflon
 - 3. Valve Class 300: Stainless Steel and Bronze
 - iv. Wafer Check Valve shall consist of a compact Body with a single plate disc attached to a hinge which in turn is supported by a hinge pin inside an off-center body cavity
 - v. The Disc shall be mechanically biased to the closed position by a torsional spring located between two hinged lugs. The hinge pin shall be retained by two NPT Pipe Plugs inside the body.
 - vi. An eyebolt shall be located on the top of the Valve to aid easy installation
 - vii. Wafer Check Valve shall be designed to open when a pressure of less than 1 psi (0.07 bar) is applied across the face of the Disc
 - viii. Wafer Check Valve shall be provided for installation inside the bolt circle and between standard flanges, using flat faced gaskets
 - ix. Wafer Check Valve shall be hydrostatically tested with a zero leakage criteria in both horizontal and vertical configurations
 - x. Wafer Check Valve shall be available in sizes from 1 to 24 inch (25 to 600mm)
- b. Thermoplastic Wafer Check Valve
- i. Acceptable Manufacturers
 - 1. Asahi/America
 - 2. Hayward Industrial Plastics
 - 3. Spears Manufacturing
 - ii. Wafer Check Valve shall be of solid thermoplastic construction, having not metal that comes in contact with the media. PVC shall conform to ASTM D1784 Cell Classification 12454
 - iii. Valves shall incorporate a single disc design suitable for either horizontal or vertical installations
 - iv. Valves shall be wafer style conforming to ASME/ANSI B16.1 face to face dimensions for Valve Class 150 flanges
 - v. Valves shall be round body design with O-ring seals of either EPDM or FKM and accept as an option a SWP-B ETFE coated spring for use in vertical applications
 - vi. Wafer Check Valves shall be bubble tight shut-off with the following pressure ratings based on ambient temperature:
 - 1. Sizes 4 to 8 inch (100 to 200mm): 150 psi (1.0 MPa)
 - 2. Sizes 10 to 12 inch (250 to 300mm): 85 psi (590 kPa)
 - vii. An eyebolt shall be located on the top of the Valve to aid easy installation
 - viii. Wafer Check Valve shall be designed for a minimum opening pressure as follows

1. Without Spring: 0.01 psi (69 Pa)
2. With Spring: 0.01 psi (69 Pa) Horizontal, 0.02 psi (0.14 kPa) Vertical
- ix. Wafer Check Valve shall be designed for a minimum sealing pressure
 1. Without Spring: 1 psi (6.9 kPa)
 2. With Spring: 1 psi (6.9 kPa)
- D. Gate Valves
 1. Cast Iron Gate Valve
 - a. Acceptable Manufacturers
 - i. NIBCO, Incorporated
 - ii. Crane Company
 - iii. Red-White Valve Corporation
 - b. Cast iron body, bonnet, and hand wheel
 - c. Standard ANSI flange with non-rising stem
 - d. Fitted to gun metal seats, bronze spindles and gun metal nuts
 - e. Clockwise closing direction when viewed from above and clearly marked on hand wheel of each valve
 - f. Standard waterworks pattern complying with requirements of AWWA C509 for minimum working pressure of 200 psi (1.4 MPa)
 - g. All valves shall be tested by the manufacturer prior to shipment. Test documents shall be available upon request
 2. Thermoplastic Gate Valve
 - a. Acceptable Manufacturers
 - i. Asahi/America
 - ii. Hayward Industrial Plastics
 - iii. Spears Manufacturing
 - b. Gate Valve body shall be one piece thermoplastic PVC conforming with ASTM D1784 with FKM or EPDM seals
 - c. Plug shall be PVC or Polypropylene tapered cylindrical plug
 - d. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for Class 150 flanges
 - e. The Valve shall have a Non-rising Stem, Visual Position Indicator, Hand wheel for operation, and a Clean-out Plug on the bottom of the valve body
 - f. Clockwise closing direction when viewed from above and clearly marked on hand wheel of each valve
 - g. Gate Valves shall be bubble tight shut-off with the following pressure ratings based on ambient temperature:
 - i. Sizes 1-1/2 to 8 inch (40 to 200mm): 150 psi (1.0 MPa)
 - ii. Sizes 10 (250mm): 110 psi (758 MPa)
 - iii. 12 to 14 inch (300 to 350mm): 75 psi (517 kPa)

- ## Water Feature Valves, Gauges, and Meters

4. Valve shall have a calibrated flow indicator lever handle
5. End connections shall be threaded
6. Valve shall have a pressure rating of 150 psi (1.0 MPa) for all sizes at ambient temperature
7. All Valves shall be tested by the manufacturer prior to shipment. Test documents shall be available upon request

G. Level Control Valves

1. Metal Float Valve
 - a. Acceptable Manufacturers
 - i. CLA-VAL Company
 - ii. Approved Equal
 - b. The Valve shall be hydraulically operated, single diaphragm-actuated, globe or angle pattern
 - c. The Valve shall consist of three major components:
 - i. The Body with seat installed
 - ii. The Cover with bearing installed
 - iii. The Diaphragm assembly
 - d. The Diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure
 - e. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot control. No separate chamber shall be allowed between the main valve cover and body
 - f. Valve body and cover shall be of cast material. Ductile Iron is standard and other materials shall be available. No fabrication or welding shall be used in the manufacturing process
 - g. The Valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as a seating surface
 - h. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used
 - i. The Diaphragm assemble contains a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures and shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat.
 - j. The Seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the

cover end to receive and affix such accessories as may be deemed necessary.

- k. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure.
 - l. The Diaphragm must withstand a Mullins Burst Test of a minimum of 600 psi (4.14 MPa) per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity.
 - m. The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 6 inch (150mm) and smaller size valves shall be threaded into the cover body. The valve seat in 8 inch (200mm) and larger size valves shall be retained by flat head machine screws for ease of maintenance.
 - n. The Valve Manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three (3) years from the date of shipment, provided the valve is installed and used in accordance with all applicable instruction.
 - o. The Float Control shall be a rotary disc, plate-type pilot. The Pilot shall direct supply pressure into the cover of the main valve to close it. Then vent the cover of the main valve to atmosphere to open the main valve
 - p. The Valve shall open wide then the float is at a low liquid level and close drip tight when the float is at a high liquid level. Once the pilot signals the main valve to open or close, the valve shall travel through its entire stroke without additional movement of the pilot control
 - q. Float shall be constructed of stainless steel with KFM or EPDM seals
2. Thermoplastic Float Valve
- a. Approved Manufacturers
 - i. Hudson Valve Company, Incorporated
 - ii. Approved Equal
 - b. The Float Valve shall use fluid pressure, as opposed to a lever arm and ball, as the force to close the valve.
 - c. The Valve shall be of a self-contained design. The valve body shall be constructed of glass-filled nylon 6/6. Internal parts shall be of ABS plastic, silicone, and stainless steel
 - d. The Valve shall have threaded female connection.
 - e. Valve shall have the following operating pressure:
 - i. Size ½ inch (15mm): 8 to 65 psi (55 to 448 kPa)
 - ii. Size 1 inch (25mm): 8 to 100 psi (55 to 689 kPa)
 - f. The maximum fluid temperature shall be 90 °F (32 °C), with a high temperature model with a maximum fluid temperature of 150 °F (65 °C)

H. Combination Air and Vacuum Valves

1. Acceptable Manufacturers
 - a. APCO
 - b. Crispin
 - c. Valmatic
2. Cast iron body, cover, and baffle
3. Stainless steel floats, stem, and bushing
4. Seats shall be KFM or EPDM
5. Valve shall allow unrestricted venting or re-entry of air
6. Fittings shall be threaded

I. Backflow Prevention Device

1. Acceptable Manufacturers
 - a. DeZurik
 - b. FEBCO
 - c. Watts
 - d. Zurn Industries, LLC
2. Reduced Pressure type
3. Epoxy coated cast iron body
4. Standard ANSI flanged end connections
5. 316L Stainless Steel strainer
6. Fasteners shall be 316L Stainless Steel
7. Assembled with four (4) test cocks
8. Non-Treaded vent outlet
9. ASSE Listed 1013, CSA Certified, UL Classified 2, FM Approved 32; IAPMO® Listed

2.2 GAUGES AND METERS

A. Pressure Gauges

1. Acceptable Manufacturers
 - a. Dwyer Instruments
 - b. WIKA Instrument Corporation
 - c. Marshall Town
2. Gauge shall be easy to read oversized 4 inch (100mm) diameter face. The Contractor may substitute a 2.5 inch (65mm) diameter face only with the approval of the Engineer of Record
3. Gauge shall be liquid filled with glycerin
4. Gauge shall have a 304 stainless steel case with 316 stainless steel wetted parts and polycarbonate lens
5. Gauge shall have a white aluminum dial with a black aluminum pointer
6. Connections shall be lower or back mount
7. Gauge shall have the following accuracy:
 - a. 4 inch (100mm) +/- 1.0% of span ASME B40.100 Grade A
 - b. 2.5 inch (65mm) +/- 2.5% of span ASME B40.100 Grade 1A

8. Gauge shall have the following range:
 - a. 0 to 60 psi (0 to 420 kPa) for pumps with a TDH of 60 feet (18m) or higher
 - b. 0 to 30 psi (0 to 210 kPa) for pumps with a TDH less than 60 feet (18m)
- B. Thermometer (Temperature Indicator)
 1. Acceptable Manufacturers
 - a. H.O. Trerice Company
 - b. WIKA Instrument Corporation
 2. Type:
 - a. 7 inch (180mm) Adjustable Angle Industrial
 - b. 3.5 inch (89mm) Direct Mount Adjustable Angle Dial
 3. Stainless Steel stem with acrylic window
 4. Use with 316 stainless steel thermowell
 5. Accuracy within +/- one (1) scale division
 6. Liquid Actuated with Aluminum white background with black graduations and markings
 7. Range from 30 to 180 °F (0 to 82 °C)
- C. Temperature Probe
 1. Acceptable Manufacturers
 - a. H.O. Trerice Company
 - b. Dwyer Instruments
 2. Type:
 - a. RTD sensor with remote cable to PLC or Filter Control Panel
 - b. Visual display at probe location
 - c. 9 inch (230mm) scale with adjustable angle probe
 3. Range from 30 to 180 °F (0 to 82 °C)
 4. Stem shall be 316 stainless steel, ¼ inch (15mm) diameter
 5. Insulation shall be Ceramic
 6. Head shall be stainless steel
 7. Use with 316 stainless steel thermowell
- D. Flow Meters
 1. Paddlewheel Flow Meters
 - a. Acceptable Manufacturers
 - i. Seametrics
 - ii. George Fischer Signet
 - iii. Blue-White Industries, LTD
 - iv. Data Industrial

- b. Insertion paddle wheel type sensor sized to fit pipe in which it is installed. Provide sensor with sufficient cable length to route cable between sensor and display horizontal across ceiling and walls and vertically down walls
 - c. Meter shall have an accuracy within +/- 1.0 percent of indicated flow
 - d. Meter shall be capable of operation in raw water and in filter backwash effluent
 - e. A remote, wall mounted display in a non-metallic, splash proof enclosure with a clear cover shall be connected to the inserted sensor
 - f. Remote display shall be provided with a factory provided power converter that can be plugged into an outlet
 - g. Flow rate shall be displayed on an easy-to-read digital display in gallons per minute (liters per minute or cubic meter per hour)
 - h. Total flow shall be displayed on an easy-to-read digital display in gallons (liters)
 - i. Flow totalizer shall be fully re-settable
 - j. Remote display shall have a 4-20 mA output where noted on the Contract Documents
 - 2. Pitot Tube Flow Meter
 - a. Acceptable Manufacturers
 - i. Blue-White Industries, LTD
 - ii. Approved Equal
 - b. Meter body shall be constructed of one piece cast acrylic and float shall be 316 stainless steel on standard range models
 - c. Meter shall be dual scale (gpm/lpm) printed on both sides of the meter
 - d. Meter shall mount to existing pipe, with no unions or adapters required
 - e. Meter shall be available with models for horizontal and vertical installations
 - f. 300 series stainless steel clamps and neoprene gasket shall be included
 - g. Meter shall be sized to pipe and flow rate
- 2.3 Valve Actuators
- A. Electric Actuator
 - 1. Actuator shall be provided by the same Manufacturer as the valve
 - 2. Electric Actuator shall be reversing type capacitor run motor design, thermally protected with a permanently lubricated gear train
 - 3. Actuator shall be provided at the voltage specified in the Contract Document
 - 4. Enclosure shall meet NEMA 4X, 7 and 9
 - 5. Actuator to have heat-treated solid metal gearing in a die cast aluminum housing and shall be powder coated with stainless steel trim for corrosion resistance
 - 6. Actuator shall have a beacon position indicator, manual override, and ISO bolt pattern for valve mounting
 - 7. Manual override is used for declutching motor for manual operation
 - 8. Two (2) limit switches shall be supplied as a standard for setting open and closed limits

9. Actuators to have two (2) ½ inch (15mm) NPT conduit entry for ON-OFF units and modulating units

B. Pneumatic Actuator

1. Actuator shall be provided by the same Manufacturer as the valve
2. Actuator shall be double piston, rack and pinion design double acting air-to-air operation
3. Actuator shall have ISO mounting pattern for valve with NAMUR mounting pattern for solenoids and accessories
4. Valves 4 inch (100mm) and smaller to include flats on actuator shaft for manual override
5. Valves larger than 4 inch (100mm) shall include de-clutchable gear operated manual override
6. Actuator body shall be of highly corrosion resistant glass filled polyamide or aluminum with Rilsan coating
7. Solenoid valve to be NEMA 4, with manual override and speed controls, NAMUR mount design
8. Actuators shall incorporate adjustable travel stop 0 – 90 degrees
9. Stops shall allow independent adjustment of opening or closing direction
10. Actuators shall incorporate valve position limit switches coupled to the valve shaft and indicating to the PLC the fully OPEN or CLOSED position of the valve
11. Supply air working pressure range 80 to 120 psi (550 to 830 kPa)
12. Actuator seals shall be Buna N
13. Actuator shall have integral thermal overload protection with auto-reset
14. Actuator shall have a permanently lubricated gear train
15. Actuator shall have adjustable travel-stop limit switches
16. Actuator shall be capable of being operated by a 24 volt signal from filter control center and separate HAND-OFF-AUTO switch
17. Fully field adjustable closure stops to limit the percent of valve closure to assure proper system flow rate

2.4 ACCESSORIES

A. Wye Strainers

1. Approved Manufacturers
 - a. ASAHI/America
 - b. Hayward Industrial Plastics
 - c. Spears Manufacturing
2. Transparent PVC body with minimum 150 psi (1.0 MPa) working pressure rating
3. True union end connections
4. EPDM or KFM seals and O-rings
5. Stainless steel strainer screen

B. Valve Boxes

1. Cast Iron Valve Box
 - a. Approved Manufacturers

- i. Bingham and Taylor
 - ii. Approved Equal
 - b. Cast Iron three piece valve box
 - c. Two (2) piece, sliding type barrel with 5.25 inch (130mm) shaft
 - d. Flanged upper section with bearing area to prevent settling
 - e. Cast Iron cover marked "IRRIGATION"
2. FRP Valve Box
- a. Approved Manufacturers
 - i. A.S.A. Manufacturing, Incorporated
 - ii. Approved Equal
 - b. Box shall be constructed of premium fiberglass and resin for maximum structural strength
 - c. Provide durable smooth gelcoat interior finish
 - d. Box shall be custom sized for the number of valves and dimensions as shown on the Contract Documents
 - e. Provide open bottom for drainage and hinged, lockable landscape lid with handle

PART 3 - EXECUTION

3.1 GENERAL

- A. All Valves, Gauges, Meters, and accessories shall be installed in strict accordance with Manufacturer's instructions and recommendations
- B. Position all Valves, Gauges, Meters, and accessories to result in good appearance, easily read, and easy access to all components for maintenance and repairs.

3.2 EXAMINATION

- A. Examine surfaces, substrates, and conditions for compliance with requirements of other sections that related work is specified, and determine if surfaces, substrates, and conditions affecting performance of the Work of this section are satisfactory. Do not proceed with the Work of this section until unsatisfactory conditions have been corrected in a manner acceptable to the installer. Starting installation constitutes acceptance of surfaces, substrates, and conditions

3.3 PREPARATION

- A. Determine depth, size, and alignment of existing utilities before beginning excavation
- B. Hot dip galvanize all metallic items that are not factory furnished

3.4 INSTALLATION

- A. Buried Valves
 - 1. Locate shut-off valves as close to main lines as possible while maintaining easy valve access
 - 2. Valves shall be the same size as the connecting pipe. Where pipe reduces near the valve, size the valve to the large diameter pipe

3. Valves less than 3 inch (80mm) located in landscape areas shall have a standard 2 inch (50mm) irrigation valve box, PVC riser, and cover. Riser shall extend up to a level of 6 inches (150mm) above finish ground surface
4. Valves 3 inch (80mm) and larger located in landscape areas shall have an 8 inch (200mm) Schedule 40 PVC pipe that extends from a level of 6 inches (150mm) above finish ground surface down to a point that is 4 inches (100mm) below the top of the operating lug nut that fully encloses the operating lug nut/handle. The pipe shall act as a valve key box and be fitted with removable, tight fitting PVC cap
5. Buried valves located in walkways or vehicular traffic areas shall have a cast iron valve box with cover, mounted flush with the finished surface and fully enclose the operating nut or handle
6. Provide three (3) valve keys for each 5 foot (1.5m) increment of depth from 5 feet (1.5m) to the depth of the deepest valve
7. Valves installed in valve boxes shall have wheel or lever operators, with valves installed so flow through the valve is horizontal and the riser and operator on the top of the valve
8. Buried Valves 6 inch (150mm) and larger shall be supported and anchored with concrete blocks to support the valve weight and provide resistance to thrust

B. Above Ground Valves

1. Locate equipment shut-off valves and check valves as close to equipment as possible, while maintaining Manufacturer's recommendations and easy valve access
2. Valves shall be the same size as the connecting pipe. Where pipe reduces near the valve, size the valve to the large diameter pipe
3. Overhead valves should be located in accessible areas next to equipment, not directly above equipment
4. Butterfly Valves installed above 7 feet (2.1m) from the finish floor elevation shall be provided with chain operators. The chain shall be located in a manner that they do not hang down in walkways or become tangled with equipment and piping
5. Ball Valves installed overhead shall be located so access to the valve can be easily accomplished with a step ladder
6. Install overhead valves with operators (handles, levers, or wheels) at 90 degrees from vertical, do not install valves with operators upside down
7. Install Valves larger than 3 inch (80mm) with flanges or between flanges. Valves 3 inch (80mm) and smaller shall be installed with socket welded union type connections
8. Do not use Valves to straighten misaligned pipes. Do not install valves between misaligned pipes
9. Provide supports, hangers, and anchors for valves to adequately support valve weight and to resist thrust
10. Support Valves adequately at both flanges if in a horizontal position and by the top flange if in a vertical position

C. Submerged Valves

1. Locate submerged valves within 12 inches (300mm) of walls. Anchor valves to walls
2. Valves shall be the same size as the connecting pipe. Where pipe reduces near the valve, size the valve to the large diameter pipe
3. Valves located in lagoons, waterfalls, or inlet/outlet boxes shall have a 2 inch (50mm) operating nut for valves 6 inch (150mm) and larger, and lever operator for valves less than 6 inch (150mm)
4. Valves located in balance tanks or surge chambers shall have a 2 inch (50mm) operating nut on a riser stem which shall extend 2 inches (50mm) below the finished surface of the tank lid. Place a removable cast iron cover over operating nut. Cast iron cover shall be flush with the finished surface of the tank lid. Located valve gear boxes above water level

D. Level Control Valves

1. Install Float Valves in a cast-in-place or pre-cast concrete or FRP box with access hatch, or in a balance tank as indicated on the Contract Documents
2. Install Float Valve with Isolating Ball Valve and a bypass with a normally closed, locking handle Ball Valve
3. Install valve float in a 12 inch (300mm) diameter PVC pipe as a stilling well
4. Stilling well shall be connected to the main water body with a minimum 6 inch (150mm) equalizer line for remote fill box applications
5. Adjust valve float to maintain water level within 1 inch (25mm) of planned water level

E. Combination Air and Vacuum Valves

1. Install Air/Vacuum Valves in all high points in above ground and below ground pressure pipelines and in locations indicated on the Contract Documents or as directed by the Engineer of Record
2. Air/Vacuum Valves installed on below grade site piping shall be installed in pre-cast concrete or FRP boxes with removable lids. Provide a drain in the box that is piped to a sump or storm drain system
3. Valves installed above ground shall be piped with PVC pipe to the nearest floor drain. Size drain pipe to the Air/Vacuum Valve
4. Air/Vacuum Valves shall be sized per the Manufacturer's recommendations for size of pipe, pressure, and conditions where valve is to be installed

F. Backflow Preventer

1. Install backflow preventer as per local code requirements on all potable water fill lines, hose bibs, and emergency eyewash/showers. Combine potable fill lines in a suitable manner to minimize the number of backflow devices
2. Install gate valves before and after backflow prevention devices
3. Size backflow prevention devices to match inflow pipe size
4. Pipe relief from backflow preventer to nearest drain or into a sump. Provide a minimum 6 inch (150mm) air gap between device and drain pipe

G. Pressure Gauges

1. Install Pressure Gauges as indicated on Contract Documents and in locations where they are easily read. Install in a vertical to 15 degrees of vertical position
 2. Pressure Gauge should not be installed more than 6 feet (1.8m) above the finished floor
 3. Install Pressure Gauge with pulsation dampers. Provide a gauge cock to isolate each gauge
 4. Adjust Pressure Gauge to final angle, clean windows and lenses, and calibrate to zero
- H. Flow Meters
1. Install flow sensor at locations as indicated on the Contract Documents. Install per Manufacturer's recommendations for preceding and following pipe lengths clearances and orientations
 2. Flow sensors for paddle wheel Flow Meters shall be installed in the pipe using as saddle or other means as recommended by the Manufacturer
 3. Install Flow Meters or Display Units in a location that is near the sensor with ready access and visibility
 4. Mount Display Units 5 feet (1.5m) above the finish floor
 5. Provide a service outlet at a location near the Display Unit
 6. Calibrate Flow Meter display as per Manufacturer's recommendations
- I. Wye Strainers
1. Install Wye Strainers as indication on the Contract Documents and in locations where they are easily accessible
 2. Install Wye Strainers in pipes where flow is horizontal or vertically down. For horizontal flow, install with the strainer vertically down
 3. Install a shut-off valve immediately next to the Wye Strainer on the upstream side for isolation
- J. Dielectric Connections
1. Isolate copper pipe from steel supports with suitable insulator
 2. Dielectric connections shall be installed in vertical sections of piping only
 3. Copper system shall have brass fittings, including connections to equipment

END OF SECTION

SECTION 13 1601 – WATER FEATURE GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Provide labor, materials, and equipment necessary for completion of the Work in the Water Feature Electrical Specification and as described in the Contract Documents
- B. Related Sections:
 - 1. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 2. SECTION 13 1503 – WATER FEATURE FILTERS
 - 3. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 4. SECTION 13 1507 – WATER FEATURE HEATERS
 - 5. SECTION 13 1511 – VALVES, GAUGES, AND METERS
 - 6. SECTION 13 1602 – WATER FEATURE CONTROLS
 - 7. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
 - 8. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
 - 9. SECTION 26 0000 – ELECTRICAL

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data:
 - 1. Submit Manufacturer literature for the following:
 - a. Wiring Devices
 - b. Disconnect Switches
 - c. Panel Boards
 - d. Motor Starters
 - e. System Field Switches
 - 2. Provide the following information for each item of equipment:
 - a. Catalog Sheet
 - b. Assembly Details of Dimension Drawings
 - c. Installation Instructions
 - d. Manufacturer's Name and Catalog Number
 - e. Name of Local Supplier
 - f. Name of Electrical Contractor
 - 3. Do not purchase equipment before approval of Product Data
- C. Shop Drawings: Submit Shop Drawings for Panel Boards and Control Panels
- D. As-Built Drawings: Provide the following:
 - 1. Complete set with all changes made to original drawings
 - 2. Provide CAD files as well as prints. Hand-drawn changes are not acceptable

E. Operation & Maintenance Manual

1. Provide two (2) copies of Operation and Maintenance Manuals

- a. Binder – Loose-leaf type with hard cover. Title on outside of front cover and on spine shall be as follows:

***** Meridian Temple Fountain *****
OPERATION & MAINTENANCE MANUAL
ELECTRICAL

- b. Title Page: List the following information:

- i. Name of Project
- ii. Project Completion Date
- iii. Name and Address of Architect, Electrical Engineer, General Contractor, Electrical Contractor, and Suppliers

- c. Table of Contents

- i. List equipment in order that it appears in the Binder

- d. Dividers:

- i. Provide one (1) divider tab for each type of equipment listed in the Table of Contents. Properly label tabs

- e. Equipment Information: Provide the following information for each item of equipment

- i. Catalog Sheets
- ii. Assembly Details or Dimension Drawings
- iii. Installation, Operation, and Maintenance Instructions
- iv. Manufacturer's Name and Catalog Number
- v. Name of Local Supplier

- f. Furnish such information for the following equipment and arrange as listed:

- i. Wiring Devices
- ii. Disconnect Switches
- iii. Panel Boards
- iv. Motor Starters
- v. System Field Switches

1.3 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Furnish UL listed equipment where such label is available. Install in conformance with UL Standards where applicable

- B. Install electrical Work in accordance with Contract Documents, edition of NEC in effect at the project location, recommendations of NFPA, state and local electrical and building codes, and special codes having jurisdiction over specific portions of the Work. This includes, but is not limited to the following:

1. NFPA 70 – National Electrical Code (NEC) with applicable local amendments

2. International Building Code (IBC)

- C. In the event of a conflict between the Contract Documents and such codes, notify the Architect/Engineer in writing prior to bid. A ruling will then be made by Architect/Engineer in writing
- D. Obtain permits and certificates of approval from all authorizes having jurisdiction over installation and pay all fees required for scope of Work being done including connection fees, impact fees, power company installation cost, etc

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS:

- A. Where Manufacturer names appear, other Manufacturers may be substituted upon obtaining written approval from the Architect/Engineer at least ten (10) days prior to opening of bids
- B. Any prior approval of alternate equipment does not automatically exempt the supplier from meeting the intent of these specifications. Failure to comply with the operational and functional intent of these specifications may result in the total removal of the alternate system at the expense of the Contractor

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Confirm dimension, ratings, and specification of equipment to be installed and coordinate these with site dimensions and with other Sections. Coordinate electrical equipment location with other trades to maintain required working clearances and prevent encroachment into such working spaces
- B. Electrical Drawings are diagrammatic. Do not scale for exact sizes or locations. Drawings are not intended to disclose absolute or unconditional knowledge of actual field conditions. Some equipment may need to be relocated from the locations indicated on the drawings to maintain working spaces around equipment. Any such coordination and relocation shall be the responsibility of the Electrical Contractor
- C. Confirm and verify electrical power specification (i.e. voltage, phase, amperage, etc) and electrical equipment and material requirements for all water feature equipment provide by others, before beginning rough-in. All coordination shall be done with the approved shop drawings or submittals
- D. Be prepared to relocate any outlet or device 6 feet (1.8m) in any direction without additional charge to the Owner
- E. Install equipment in accordance with the Manufacturer's recommendations
- F. In the event of a conflict between specifications and drawings or between various areas on the Contract Documents the most stringent requirements shall govern

3.2 FIELD QUALITY CONTROL

- A. Test systems and demonstrate equipment as working and operating properly. Rectify defects at no additional cost to the Owner
- B. All Work under this section shall be executed in a thorough workmanlike manner, as determined by the Engineer, by competent and experienced journeyman electricians
- C. All Work shall be installed in strict conformance with all Manufacturer's requirements and recommendations

3.3 IDENTIFICATIONS

- A. Provide for each Panel Board, Terminal Cabinet, Motor Starter, Motor Controller, Pushbutton, Control Switch, etc, furnished and/or installed under this section of the specifications, with identification as to its designation or specific function.
 - 1. Identification shall be laminated, white core, black plastic nameplate with beveled edges. Lettering shall be machine engraved, not less than 3/16 inch (5mm) high, cut through the black surface to the white core.
 - 2. Secure nameplate to the identified item by the use of stainless steel self-tapping screws.
 - 3. Impressed plastic shall not be used to satisfy this requirement.
- B. Panel schedules shall be typed and easily legible

3.4 GUARANTEE-WARRANTY

- A. Guarantee Work to be free from defects of materials and workmanship for a period of one (1) year from date of final acceptance of building by authorities having jurisdiction
- B. Furnish Owner with three (3) written copies of Guarantee-Warranty

END OF SECTION

SECTION 13 1602 – WATER FEATURE CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Pump Control
2. Sand Filter Backwash Control
3. Regenerative Filter Bump and Regeneration Control
4. Chemical Control
5. Secondary Disinfection (Ozone) System Control
6. Temperature Control
7. Backwash Tank Management
8. Underwater Lighting Control
9. System Alarms and Shutdown Trips

B. Related Sections:

1. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
2. SECTION 13 1503 – WATER FEATURE FILTERS
3. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
4. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
5. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
6. SECTION 13 1507 – WATER FEATURE HEATERS
7. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
8. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
9. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
10. SECTION 13 1513 – WATER FEATURE LOW PRESSURE AIR SYSTEMS
11. SECTION 13 1601 – WATER FEATURE GENERAL ELECTRICAL REQUIREMENTS
12. SECTION 13 1604 – WATER FEATURE FIELD INSTRUMENTS, SWITCHES, AND ALARMS
13. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
14. SECTION 13 1606 – WATER FEATURE INSTRUMENT POWER SYSTEMS
15. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS
16. SECTION 13 1608 – WATER FEATURE LIGHTING AND CONTROL
17. SECTION 13 1609 – WATER FEATURE DISCONNECTS, MCC, AND STARTERS
18. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
19. SECTION 13 1611 – WATER FEATURE GROUNDING

PART 2 - PRODUCTS

2.1 NOT APPLICABLE

PART 3 - EXECUTION

3.1 FUNCTIONAL REQUIREMENTS

- A. The System shall provide ~~all-of-all~~ the functions described herein for each system. Major equipment items are specified for each loop; however, all items of equipment, whether indicated or not, which are necessary to affect the required performance shall be provided
- B. Water Feature Control Systems (WFC): The WFC includes controlling and monitoring of pumps, water filtration, chemical feed systems, secondary disinfection systems, temperature control, and lighting. These systems shall be controlled via a Control Panel (CP-X) and/or a Motor Control Panel (MP-X). Refer to Contract Documents for panel designations

3.2 PUMP CONTROL

- A. All pump controls shall include the following:
 1. HAND-OFF-AUTO (HOA) selector switch, as shown on the Contract Documents, at the Motor Control Center (MCC-X) and with appropriate disconnects
 - a. When the switch is in the HAND position, the pump shall operate unless inhibited by PLC control safety interlock
 - b. When the switch is in the OFF position, the pump shall stop
 - c. When the switch is in the AUTO position pump control shall be determined by the Programmable Logic Controller (PLC) output relay in the PLC panel
 - d. When in either HAND or AUTO, the pump shall be stopped by a PLC output relay in the PLC panel
 2. Each direct suction connected pump shall have a Vacuum Limit Switch (VLS) interlock as indicated on the drawings. The VLS will operate as follows:
 - a. The VLS shall be preset on site prior to commissioning to meet each pump's vacuum limit when pump suction is excessively restricted.
 - b. When the VLS is activated the PLC shall shut down the associated pump. The Human Machine Interface (HMI) will indicate that the pump has been shut down due to high vacuum condition.
 - c. Filtration Pump(s), (typically identified as Treatment Pump P-X01, ...), shall include the following addition controls when the pump is turned off either with the associated HOA switch in the OFF position or through PLC interlock with the HOA in AUTO:
 - i. All associated Feature Pumps, Chemical Feed Pumps, Secondary Disinfection Systems, and temperature control operations will cease to operate regardless of their modes of operation
 - ii. HMI indicates that each of the Feature Pump(s) and other ancillary systems operations are suspended while the Treatment Pump is not operational.
 - d. All Pumps with Emergency Stop Controls (E-STOP) shall include the following additional controls:
 - i. When the E-STOP is activated the associated pump will stop immediately.
 - ii. All pumps receiving water from the same feature as the pump listed above shall also stop
 - iii. Notification will be sent to the HMI indicating that all pumping activities have been suspended due to the activation of the E-STOP
 - iv. Operation of associated pumps cannot be continued until the E-STOP is reset and the fault acknowledged on the HMI.
 - v. When an E-STOP has shut down a Treatment Pump an 80 dBA alarm shall sound in conjunction with the pump shutdown
 3. All feature pumps not associated with the filtration and chemical treatment of the water shall include a control timer within the PLC that may turn the pumps ON and OFF based on and operator adjustable set points adjustable through the HMI.

3.3 SAND FILTER BACKWASH CONTROL

- A. Function: To monitor and control the Water Treatment Pumps (WTP), Filter Control Panel (FCP), and control the position of the Motorized Backwash Control Valve (MBCV)
- B. Components:
 1. WTP
 2. FCP
 3. MBCV
 4. MBCV – AUTO-OFF-OPEN-CLOSE selector switch

5. PLC I/O in CP
- C. Operation:
 1. General:
 - a. The FCP controls the operation of the Filtration System and should be provided by the Filter Manufacturer
 - b. When operated in MANUAL, filter backwashing may be accomplished manually
 - c. When operated in AUTO, the FCP determines when a backwash is necessary, and when it may be allowed
 - d. The normal mode of operation of the System shall be when the WTP is in AUTO and circulating water through the Filters to the features
 - e. Normal mode of the FCP will be AUTO
 2. Manual Backwash:
 - a. For multiple filter tank operation each filter tank shall be backwashed separately. Only one filter shall backwash at a time throughout all systems in the mechanical room.
 - b. Operator shall manually change position of the valves located at the inlet and outlet of each filter element and position the MBCV (if so equipped). If inlet and outlet valves are not linked, then the Operator shall turn OFF the WTP while valve position is changed, then turn the WTP back ON.
 - c. The valve change allows the water to reverse flow through the filter and direct the backwash water to the Backwash Tank or sewer connection
 - d. Backwash shall continue for sufficient time to fluidize the sand bed and flush the filtrate. Backwash progress may be monitored visually with the backwash sight glass. When water stream in the sight glass appears clear back wash may be stopped – valves returned to normal filtering position
 - e. Repeat process sequentially for each filter in a given system. Once all filters in a given system have been backwashed the filter pressure drop is verified. If the differential pressure is not down to “Clean” filter conditions the backwash sequence should be repeated.
 3. Automatic Backwash:
 - a. Automatic Backwash operation differs from Manual operation by automating the valve change sequence and allowing the FCP to configure and position the valves based on either an operator initiated command to start the sequence or automatically due to measured pressure differential or elapsed time.
 - b. For multiple filters on a single system the FCP shall backwash each filter tank sequentially inhibiting multiple filters from backwashing simultaneously.
 - c. For the AUTO operation to occur, the following modes shall be assumed:
 - i. The WTP(s) operation HOA switch is in the AUTO position
 - ii. The FCP is in AUTO mode
 - iii. The BWCV local control switch is in the AUTO position
 - d. Backwash Sequence:
 - i. STEP 1: The PLC in the CP shall monitor the FCP “Stop Pump” output. When the FCP signals the PLC the corresponding WTP(s) shall be stopped.
 - ii. STEP 2: When the FCP signals the PLC for a backwash cycle to begin the PLC causes the MBCV to partially close (this position should be set during start-up with limit positioners on the MBCV actuator). The partially CLOSED MBCV provides a flow restriction in the outlet piping resulting in an increase flow through the filter element being backwashed. The MBCV shall remain in this partially closed position until all of the elements in the filter bank have been backwashed sequentially.

- iii. STEP 3: The FCP then repositions the inlet and outlet valves of filter #1 to Backwash position.
- iv. STEP 4: FCP receives confirmation that valves are repositioned and signals the PLC to re-start the WTP(s).
- v. STEP 5: When one filter element has been backwashed for a predetermined time period, the FCP shall stop the WTP, reposition the backwashed filter element valves back to normal operating position, and re-position the valves on the next element to be backwashed to backwash position.
- vi. STEP 6: Steps 4 and 5 are repeated sequentially for each filter element in turn until all filter elements have been backwashed.
- vii. STEP 7: Once all of the filter elements have been backwashed, the FCP shall signal the WTP to STOP, return the filter element valves to normal operating position, reposition the MBCV to full OPEN, and then allow the WTP to restart.

3.4 REGENERATIVE FILTER CONTROL

- A. Function: To monitor and display the function of the Regenerative Filter System Controller (FCP) and coordinate control of WTP operation during regeneration and rinse cycles.
- B. Components:
 - 1. Water Treatment Pump(s) WTP
 - 2. Regenerative Filter FCP
 - 3. PLC I/O in CP
- C. Operation:
 - 1. General:
 - a. The FCP provided by the Filter Manufacturer controls the operation of the regenerative filter including regeneration cycles, Rinse and Pre-coat cycles and vacuum transfer of media into the filter.
 - b. Filter regeneration and rinse cycles may be manually or automatically initiated
 - c. When operated in AUTO, the FCP determines when a regeneration cycle is necessary, and when it may be allowed
 - d. The normal mode of operation of the System shall be when the WTP is in AUTO and circulating water through the Filters to the features
 - e. Normal mode of the FCP will be AUTO
 - 2. Operation
 - a. During media transfer the WTP is turned "OFF"
 - b. FCP will initiate regeneration as needed or when manually initiated signaling CP to stop the WTP. FCP will then set all necessary pneumatic actuated valves and process the cycle signaling the CP to re-start WTP for pre-coat and will return the system to normal operation when cycle is complete.

3.5 CHEMICAL CONTROL

- A. Function: To monitor and control the water pH and ORP of the closed loop water systems
- B. Components:
 - 1. Chemical Controller (CC)
 - 2. Chlorine Chemical Feeder (CCF)
 - 3. pH Chemical Feeder (PCF)
 - 4. PLC I/O in CP
- C. Operation:

1. General: The CC shall sample and monitor the chemical properties of the system water. The CC shall control the CCF and the PCF via switching relays in the CC
2. The PLC shall monitor the WTP for the system and shall inhibit any chemical injection or feed unless the WTP is ON. If the WTP is ON, the PLC relay shall energize the CC to adjust the chemistry of the water

3.6 SECONDARY DISINFECTION (OZONE) SYSTEM CONTROL

- A. Function: To monitor and control the Ozone Generation and Injection, which provide additional water disinfection in association with the Chlorine Feed System
- B. Components:
 1. Ozone Booster Pump (OBP)
 2. Ozone Generator (OZ)
 3. Ozone Air Preparation System (OAP), when required
 4. ORP Controller (ORPC)
 5. Ozone Destruct Unit (DU)
- C. Operation:
 1. General: The OBP provides flow through the ozone side stream loop, which includes a venturi injector that injects the Ozone gas provided the OZ. The ozonated water flows into a pressurized vessel, Ozone Contact Tank, where the ozone is allowed to react with the water and any undissolved ozone gas is collected and off gassed through the DU. The water in the Ozone Contact tank discharged back into the main system water line. In the main line the ORP is monitored by the ORPC and provides feed back to the OZ, the ORP Probe should be located after the Ozone loop reconnects to the main line, but prior to the injection of the Chlorine Feed System
 2. The OBP shall be interlocked to the operation of the WTP. The OBP shall not operate when the WTP is OFF
 3. The PLC shall monitor the OZ and provide a display of the operation of the OZ, including the ORP reading from the ORPC
 4. Ozone destruct is a passive system wherein a catalyst converts undissolved ozone to oxygen. No control is required but the unit does require power to run a small heater to prevent condensation within the catalyst bed.

3.7 TEMPERATURE CONTROL

- A. Function: To monitor the temperature of the system water leaving the mechanical room and insure that temperature is never more than 104 °F (40 °C)
- B. Components:
 1. Temperature Probe (TP) – located on the main outlet pipe after the Heater connections
 2. Temperature display at the location of the TP
 3. PLC I/O in CP-X
 4. Heater (H)
- C. Operation:
 1. General: The TP shall monitor the temperature of the water going out of the mechanical room and back to the water feature. If the temperature of the water every exceeds 104 °F (40 °C) the PLC will de-energize the Heater
 2. The temperature set point will be adjustable on the HMI

3.8 BACKWASH TANK MANAGEMENT

- A. Function: To monitor the water level in the backwash holding tank, and permit backwashing operations only when the backwash holding tank has sufficient storage capacity to contain new backwash effluent.
- B. Components:

1. Backwash Tank Level Monitoring System (LMS)
2. Backwash Drain Valve (BDV) or Pump (BDP), when specified
3. All associated WTP Systems that contribute backwash water to the tank
4. PLC I/O in CP-X

C. Operation:

1. General: The LMS shall monitor the level of the water in the backwash holding tank. If a BDP is used the pump will turn OFF and ON based on levels with the tank to meter water out to the sewer system. If a BDV is used the valve position will be set at start-up to insure that the maximum flow out of the backwash holding tank is not greater than the site capacity. The position of the BDV shall be constant
 - a. If the water level in the tank is below the low level set point (LLS), the BDP shall not operate. If BDV is used there is no LLS
 - b. While backwash water is being discharged into the holding tank the PLC shall monitor the water level. When the level reaches the LLS (to be determined at start-up) the BDP shall automatically start, sending water to the site sewer. The BDP shall continue to operate, until the water level reaches the Low Level Shutdown (LLD), which shall be determined at start-up
 - c. Should the water level rise to the High Level Alarm (HLA), approximately 6 inches (150mm) below the top of the tank, all WTP System associated with the backwash holding tank shall be stopped and an alarm relayed to the HMI. WTP operation shall not be allowed until the water level in the backwash holding tank decreases to an acceptable level

3.9 LIGHTING CONTROL

- A. Function: To automatically turn the feature lights ON and OFF
- B. Components:
 1. PLC I/O in CP-X
 2. Feature Light Fixtures
 3. Photocell
- C. Operation: The Photocell will be mounted in a remote area adjacent to the associated water feature. The Photocell will activate the lights with a relay through the PLC

3.10 SYSTEM ALARMS AND SHUTDOWN TRIPS

- A. Mechanical Room High Water Trip
 1. Function: To monitor high water levels on the mechanical room floor and shut down electrical power
 2. Components:
 - a. Floor Water Level Switch (FLS)
 - b. Shunt Trip on MCC Main Circuit Breaker
 - c. Alarm Notification in the door of CP-X
 3. Operation:
 - a. The FLS shall be installed near the floor as shown in the Contract Documents
 - b. Should the FLS actuate, the Main Breaker shall trip, de-energizing all water feature equipment in the mechanical room. An audible alarm and Operator notifications shall be initiated
 - c. Resetting the alarm shall occur when the MCC circuit breaker is reset
 4. Pump Restart Time Delay

- a. Function: To delay restarting all motors and allow a staggered starting after Utility Power Failure
 - b. Components: Timing Relays in CP-X
 - c. Operation: When CP-X is energized, several timing relays shall begin timing, each relay shall be set for a five (5) minute cascaded delay. Various large pump loads shall not be allowed to start until the time delay for that pump is complete. The relays shall reset on loss of control power at CP-X
- B. Motor Control Center – Phase Failure Trip
 - 1. Function: To monitor the incoming AC power to the 3 phase MCC, and trip all motors on loss of any phase
 - 2. Components:
 - a. Phase Failure Sensing Relay in the MCC
 - b. Shunt Trip on the MCC Main Circuit Breaker
 - c. Operation:
 - i. The relay shall be installed in the MCC
 - ii. The relay shall monitor incoming AC power
 - iii. Should the incoming AC power feeder have a low voltage condition occur on any one of the three phases, the MCC main circuit breaker shall trip, de-energizing the MCC
 - iv. There is no indicator or horns for this alarm. Resetting the alarm shall occur when the MCC main circuit breaker is reset
- C. Ambient Ozone Alarm
 - 1. Function: To monitor the status of the Ambient Ozone monitor and shut down ozone generation in event of a high limit alarm condition.
 - 2. Components;
 - a. Ambient Ozone Monitor [AOM]
 - b. Ozone Generator(s) [OG]
 - c. Ozone Booster Pump(s) [OBP]
 - d. Ambient Ozone Alarm Indicator Strobe Light (SL)
 - e. CP HMI
 - f. Control Logic and I/O of the CP
 - 3. Operation
 - a. The “Alarm Output” relay in the AOM signals the CP that an alarm condition exists
 - b. CP shuts down all OG within the mechanical space monitored by the AOM but leaves OBP and other water treatment equipment operating.
 - c. CP activates the SL and signals operator of the alarm condition and that OG(s) are shut down via the HMI.
 - d. Operator acknowledges the Alarm condition on the AOM and takes steps necessary to correct the issue causing the fault.
 - e. CP deactivates the SL and enables operation of the OG when the Operator resets the Fault condition on the CP through the HMI

END OF SECTION

SECTION 13 1604 – WATER FEATURE FIELD INSTRUMENTS, SWITCHES, AND ALARMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Field Instruments:
 - a. Ultrasonic Level Indicators
 - b. Pressure Sensors
 - c. Temperature Sensor and Transmitter
 - d. Flow Sensor and Transmitter
 - 2. Field Switches:
 - a. Vacuum Limit Switch
 - b. Pressure Switch
 - c. Flow Switch
 - d. Liquid Level Switch
 - e. Selector Switches
 - f. Time Delay Switches
 - 3. Field Alarms
- B. Related Sections:
 - 1. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 2. SECTION 13 1503 – WATER FEATURE FILTERS
 - 3. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 4. SECTION 13 1507 – WATER FEATURE HEATERS
 - 5. SECTION 13 1511 – VALVES, GAUGES, AND METERS
 - 6. SECTION 13 1602 – WATER FEATURE CONTROLS
 - 7. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
 - 8. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
 - 9. SECTION 26 0000 – ELECTRICAL
- C. References:
 - 1. NEMA Enclosure Types
 - 2. NFPA 70 – National Electrical Code
 - 3. Underwriters Laboratories (UL)

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's literature, cut sheets indicating mounting instructions, sensor dimensions, materials, electrical requirements, and operational parameters

- C. Shop Drawings: Submit Shop Drawings indicating location of all Field Switches, Sensors, and Meters, including the following:
 - 1. Connection Diagrams
 - 2. Loop Diagrams
- D. Operation and Maintenance Data: Provide Manufacturer's instructions for installation, calibration, start-up, troubleshooting, and schedule maintenance recommendations
- E. Certifications: Provide Factory and Field Calibration Sheets for each instrument and device that requires setup and calibration. Provide Certification certifying each instrument and device has been setup and calibrated by a qualified individual
- F. Warranty: Submit Manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the Manufacturer, where applicable

PART 2 - PRODUCTS**2.1 ULTRASONIC LEVEL SENSOR/CONTROLLER**

- A. Acceptable Manufacturers
 - 1. IMO Industries, Incorporated – GEMS Sensors, ULS-60
 - 2. Approved Equal
- B. Sensor and Controller shall be one integral unit
- C. Controller shall have dual SPST output relay channels for control of pumps, valves, or alarms with selectable Normally Open or Normally Closed operation mode and latching capability
- D. Sensor shall have a resolution of 1/8 inch (3mm)
- E. Adjustment and calibration shall be accomplished by means of a potentiometer setting
- F. Enclosure shall be NEMA 4X rated
- G. Sensor shall have a range of 6 inches (150mm) to 6 feet (1.8m) with a 3.6 inch (91mm) maximum deadband

2.2 PRESSURE SENSOR

- A. Acceptable Manufacturers
 - 1. IMO Industries, Incorporated – GEMS Sensor Division, 200 Series
 - 2. Approved Equal
- B. Range: Vacuum to 100 psi (690 kPa)
- C. Operating Temperature: Water (Fresh or Salt) to 140 °F (60 °C)
- D. Operating Pressure (max): 150 psi (1.0 MPa)
- E. Output: 4-20 mA
- F. Electrical connection to be NEMA 4X rated

2.3 TEMPERATURE SENSOR AND TRANSMITTER

A. RTD Sensor

1. Acceptable Manufacturers
 - a. Terice
 - b. Approved Equal
2. Stem: 316L Stainless Steel
3. Head: Polypropylene
4. Connection: 1/2 inch (15mm) NPT spring loaded
5. Conduit Connection: 3/4 inch (20mm) NPT female
6. Use with 316L Stainless Steel thermowell provided by the same Manufacturer

B. Transmitter

1. Acceptable Manufacturers
 - a. Terice
 - b. Approved Equal
2. Transmitter shall be fully compatible with sensor
3. Transmitter to have 4-20 mA output

2.4 FLOW SENSOR AND TRANSMITTER

A. Sensor

1. Acceptable Manufacturers
 - a. Seametrics Incorporated, IP81
 - b. Approved Equal
2. Hall effect type, generating a 12 VDC current sinking pulse
3. Materials:
 - a. Sensor Body: Polypropylene or 316L Stainless Steel
 - b. Rotor: Kynar (PVDF)
 - c. Shaft: Ceramic

B. Meter/Totalizer

2.5 GENERAL SWITCH REQUIREMENTS

- A. Switches shall provide ON-OFF control action in response to changes in a measured variable
- B. Unless otherwise scheduled, provide switches with Form C (SPDT) electrical contacts
- C. Switch contacts in 120 VAC circuits will be rated NEMA B150, and switch contacts in 24 VDC circuits will be NEMA P150, unless otherwise noted
- D. Electrical contacts will be hermetically sealed and either mercury or snap action type
- E. Switched to be automatic reset type

2.6 FIELD SWITCHES

A. Vacuum Limit Switch

-
1. Acceptable Manufacturers
 - a. Static-O-Ring, No. 54NN-K117-N4-B1A
 - b. Square D Company, Class 9016, Type GAW2
 - c. Approved Equal
 2. Range: Must have an adjustable setpoint from atmospheric pressure down to a minimum of 15 inch Hg (-50 kPa vacuum)
 3. Process connection: 1/4 inch (8mm) NPT
 4. Conduit Connection: 3/4 inch (20mm) NPT conduit fitting
 5. Over-range Rating: 100 psi (690 kPa)
 6. Housing: NEMA 4X
 7. DPDT N.O. & N.C. contacts rated for a minimum 1 amp at 250 VAC
- B. Pressure Switch
1. Acceptable Manufacturers
 - a. IMO Industries, Incorporated – GEMS Sensors, 2200 Series
 - b. Approved Equal
 2. Range: Vacuum to 100 psi (690 kPa)
 3. Over-range Rating: 200 psi (1.4 MPa)
 4. Process Connection: 1/4 inch (8mm) NPT minimum
 5. Electrical connection to be shielded PVC cable
 6. Housing: NEMA 4X
 7. Output: 4-20 mA
- C. Flow Switches
1. Acceptable Manufacturers
 - a. IMO Industries, Incorporated – GEMS Sensors, FS-550 Series
 - b. Approved Equal
 2. Wetted Materials: Housing, Paddle, and Spring to be 316L S. S., Teflon, Or Ceramic
 3. Operating Pressure: 2,000 psig (14 MPa) maximum
 4. Pressure Drop: 3 psig (20 kPa) maximum
 5. Operating Temperature: -30 to 300 °F (-35 to 150 °C)
 6. Setpoint Accuracy: +/- 25%
 7. Switch Rating: SPDT, 20 VA
 8. Repeatability: +/- 5%
- D. Liquid Level Switches
1. Small Tank Float Type Switches
 - a. Acceptable Manufacturers
 - i. IMO Industries, Incorporated – GEMS Sensors, LS-3 (Vertical Mount)
 - ii. IMO Industries, Incorporated – GEMS Sensors, LS-6 or LS-7 (Horizontal Mount)

- iii. Approved Equal
 - b. Wetted Parts to be 316 Stainless Steel, Polypropylene, Teflon, or Kynar (PVDF)
 - c. Operating Temperature: Water (Fresh or Salt) to 140 °F (60 °C)
 - d. Minimum Liquid Specific Gravity: 0.65
 - e. Operating Pressure: 150 psi (1.0 MPa) maximum
 - f. Switch Rating: 20 VA
 - g. Electrical Termination: No. 22 AWG, minimum of 12 inches (300mm) long, Polymeric Lead Wires
 - h. Selectable Normally Open (NO) or Normally Closed (NC) operation by inverting float on unit stem
2. Electro-Optic Switches
- a. Acceptable Manufacturers
 - i. IMO Industries, Incorporated – GEMS Sensors, ELS-1100
 - ii. Approved Equal
 - b. Housing and Prism: Polysulfone
 - c. Operating Pressure: 0 to 150 psi (1.0 MPa)
 - d. Operating Temperature: 0 to 176 °F (-17.8 to 80 °C)
 - e. Input Power: 10-28 VDC
 - f. Mounting Type: 1/4 inch (8mm) NPT and 3/8 inch (10mm) NPT Conduit
 - g. Repeatability: +/- 1 mm
 - h. Electrical Termination: No. 22 AWG, minimum 12 inches (300mm) long lead wires with PVC jacket
3. Ultrasonic Type Switches
- a. Acceptable Manufacturers
 - i. IMO Industries, Incorporated – GEMS Sensors, ULS-60
 - ii. Flowline Liquid Intelligence, LU12-5061
 - iii. Approved Equal
 - b. Enclosure: Engineered Plastic NEMA 4X with 1/2 inch (15mm) NPT Conduit fitting
 - c. Sensor Material: Kynar (PVDF)
 - d. Deadband: 3.6 inch (91mm) maximum
 - e. Output:
 - i. 4-20 mA
 - ii. Two (2) relay channels for control and alarm with potentiometer calibration. Relays to have a minimum 20 VA rating

E. Selector Switches

- 1. Acceptable Manufacturers
 - a. Square D, Type K

- b. Allen-Bradley, Bulletin 800T
 - c. Micro Switch Division of Honeywell, Type PT
 - d. Eaton Corporation
 - e. Culter-Hammer Products, Type T
 - f. General Electric Company, Type CR
 - g. Approved Equal
2. General: Heavy Duty oil-tight with operators as specified. Engrave position legends on switch faceplate. Switches for electrical circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 VAC
 3. Motorized Backwash Control Valve – Black knob operator switch, four position, maintained contact

F. Time Delay Switches

1. Acceptable Manufacturers
 - a. Tork, A500 Series
 - b. Approved Equal
2. General: Switch shall be a spring wound, interval time switch
3. Ratings:
 - a. Single-pole, single throw
 - b. 20 amp at 125 VAC
 - c. 0 to 30 minute time duration
 - d. Color: Ivory or as specified by Architect/Landscape Architect
 - e. Install in standard 2 by 4 inch (50 by 100mm) electrical box with decorative cover plate

2.7 FIELD ALARMS

A. Emergency Shutdown Alarm Horn

1. Acceptable Manufacturers
 - a. Cooper Wheelock
 - b. Approved Equal
2. Alarm shall be an audible and strobe type
3. Audible tone shall be a selectable choice of either continuous horn or temporal pattern
4. Each tone shall have 3 dBa settings (99, 95, and 90 dBa) to choose from
5. Shall be available with a weatherproof model for outdoor use

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components as per the Manufacturer's recommendation

3.2 GENERAL

- A. Erect and install all instruments, control systems, and equipment furnished and required by the Contract Documents
- B. Furnish and install all tubing, piping, fittings and valves required to install, connect, and complete the instrumentation and control systems as specified and indicated
- C. Connect tube, pipe, and support all equipment erected and installed as specified
- D. Calibrate all instruments furnished by this section
- E. Perform loop checking and functional testing as specified
- F. Provide all testing instruments, calibration standards, and devices required to perform calibration and testing procedures
- G. Provide skilled labor and technical assistance to the Manufacturer's Service Representative for the calibration and start-up of control systems and equipment
- H. Coordinate and consult with the control systems service representative as required
- I. Place instruments and controls into successful operation
- J. Install all prefabricated cable as required in this section
- K. Wire all instrumentation and control devices are required in this section

3.3 FLOW SWITCH

- A. Switch shall be installed in a 1 inch (25mm) NPT pipe tap or saddle fitting
- B. The Contractor shall cut paddle length to suit pipe diameter in accordance with the Manufacturer's recommendations

3.4 LIQUID LEVEL SWITCHES

- 1. Float: Install as shown on Contract Documents and in accordance with Manufacturer's Installation Instructions

3.5 HYDROTHERAPY JET PUMP AND/OR BLOWER TIME SWITCH

- A. Switch shall be installed in a plastic 2 by 4 inch (50 by 100mm) or 4 by 4 inch (100 by 100mm) electrical box with a plastic cover plate. Provide and in-service weatherproof cover if located outside
- B. Install switch in a secure and accessible manner to the spa/hot tub

3.6 EMERGENCY SHUTDOWN ALARM HORN

- A. Alarm Horn shall provide an audible warning of an emergency switch actuation
- B. Alarm Horn shall remain on continuous until them emergency switch is reset

END OF SECTION

SECTION 13 1605 – WATER FEATURE CONTROL PANELS

PART 1 - GENERAL**1.1 SUMMARY****A. This section includes the following:**

1. Panel Enclosures
2. Panel Instruments and Devices
3. Panel Accessories
4. Panel Wiring

B. Related Sections:

1. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
2. SECTION 13 1503 – WATER FEATURE FILTERS
3. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
4. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
5. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
6. SECTION 13 1507 – WATER FEATURE HEATERS
7. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
8. SECTION 13 1509 – WATER FEATURE CHILLERS
9. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
10. SECTION 13 1511 – VALVES, GAUGES, AND METERS
11. SECTION 13 1602 – WATER FEATURE CONTROLS
12. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
13. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS
14. SECTION 13 1609 – WATER FEATURE DISCONNECTS, MCC, AND STARTERS
15. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
16. SECTION 26 0000 – ELECTRICAL

C. References:

1. Instrument Society of America (ISA) – ANSI/ISA-S5.4 Instrument Loop Diagrams
2. NEMA 250 – Enclosures for Electrical Equipment (1,000 Volts Maximum
3. NFPA 70 – National Electrical Code (NEC) – Article 250 Grounding
4. Underwriters Laboratories (UL)

1.2 SUBMITTALS FOR REVIEW**A. SECTION 01 3300 – SUBMITTAL PROCEDURES****B. Product Data:** Submit Manufacturer's literature for all components indicating component dimensions, weights, colors, and materials**C. Shop Drawings:** Submit the following Shop Drawings, drawn to scale. Scale shall not be less than 1 inch equals 1 foot 0 inches (1"=1'-0") for Imperial Units or 1:10 for Metric Units. Drawings shall identify all equipment, dimensions, materials, and colors

1. Panel Front View – showing equipment arrangement and dimensional information
2. Panel Floor Plan and Side View – showing dimensions, doors, and equipment layout inside the Panel
3. Drawings showing structural details of fabricated Panels and Mounting requirements
4. Internal Interconnecting Wiring Diagrams – showing Terminal Strips and all external devices connected to the Panel as required in SECTION 13 1602 – WATER FEATURE CONTROLS, design submittal for Loop and Schematic Diagrams
5. Complete Schematic and Diagrams – including terminal block and wire identification number and device location symbols consistent with the Contract Documents

6. Panel Bill of Materials – with detailed description of components and equipment data sheets
 7. Field Cable Number/ID and Terminations
 8. Factory Data Sheets for Instrumentation
- D. Operation and Maintenance Data: Provide Manufacturer's instructions for installation, general assembly instructions, and maintenance and care recommendations for all components
- E. Factory Test Certifications: Provide certification from the Panel Manufacturer indicating the Panel has been tested and is fully operational prior to shipping
- F. Warranty: Provide a written warranty for assembled Panels and Components for a minimum of one (1) year from the date of installation
- 1.3 QUALITY ASSURANCE
- A. Panel Builder Qualifications: Panel Builder shall have a minimum of five (5) years experience in building Panels and performing all Work related to this section
- B. The Contract Documents show the general arrangement of each Panel. The Panel Builder shall design the Panel layouts within the guidelines set forth and submit these layouts in accordance with the Submittals Section
- C. Panels shall be built in accordance with the approved shop drawings. All components and operations shall be tested and working prior to shipping
- D. Panels shall be shipped with one (1) complete copy of Schematic Diagrams including Terminal Block and Wire Identification Numbers
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Delivery: Deliver Panels to the job site in the Manufacturer's original, unopened packaging, clearly marked with Supplier's Name, Address, and Panel information
- B. Storage and Handling: Store Panels in a well-ventilated, clean, dry covered area. Do not store in direct sunlight or where Panels can be damaged from water or moisture

PART 2 - PRODUCTS**2.1 PANEL ENCLOSURES**

- A. Acceptable Manufacturers
1. Rittal Corporation
 2. Hoffman
 3. Approved Equal
- B. General Enclosure Requirements
1. Use NEMA 12 rated Panels for Indoor installation. Use NEMA 4X rated Panels for Outdoor installation. Specific requirements as specified herein or as indicated on the Contract Documents
 2. Size Panels in accordance with limitations indicated on the Contract Documents. Panel size is the specific requirement of the Panel Manufacturer
 3. Cabinets less than 60 inches (1.5m) high shall be provided with floor stands to raise the top of the Panel to 60 inches (1.5m) above the floor or work platform, or if the Panel weights less than 100 lbs (45 kg) and wall space is available, wall mounting may be used in lieu of a floor stand
 4. Structures and equipment shall be braced to prevent damage from seismic forces. Equipment shall not be required to function properly during periods of seismic disturbance but shall be capable of manual restart following a disturbance
 5. Cutouts for future equipment shall be blanked off with suitable covers

6. Instrument tag numbers, if used, shall be identified on the Panel rear. Name Plates shall identify face-mounted instruments. Instruments shall be mounted in a manner that allows ease of access to components and ease of removal
 7. Face-mounted instruments that are more than 6 inches (150mm) deep, weigh more than 10 lbs (4.5kg), or exert more than 4.0 ft-lbs (0.6kg-m) moment force on the face of the Panel shall be supported underneath at the rear
 8. Face-mounted equipment shall be flush or semi-flush with black escutcheons
 9. Name Plates on internal and external instruments and devices:
 - a. Materials approximate dimensions and legends as indicated on the Contract Documents made of laminated phenolic material having engraved letters approximately 3/16 inch (5mm) high extending through the black face into the white layer; firmly secured to Panels
 10. Fabricated Custom Metal Panels:
 - a. Thoroughly clean, sand, and apply a minimum two (2) coats of rust inhibiting primer both inside and outside of Panels. Apply a minimum of two (2) coats of white enamel or lacquer on Panel interior surfaces. Smooth exterior surfaces and apply a minimum of two (2) coats of enamel, polyurethane, or lacquer finish. Furnish 2 quarts (1.9 liters) of finish color paint with the Panels to cover future scratches
 11. Provide Panels with an inside pocket to hold Panel Drawings. Ship Panels with one (1) copy of accepted Submittal Drawings in a sealed plastic bag stored in the Panel drawing pocket
- C. Freestanding Custom Metal Panels:
1. Panel Custom Fabrication: Dust tight, completely enclosed cubicle formed from steel structural members and steel plates. Form base of heavy channel iron, with flanges up, and with 1/2 inch (12mm) holes drilled at 12 inch (300mm) spacing so that the Panel shall be bolted to the floor. Grind smooth welds, seams, and edges on exposed surfaces. Provide lifting facilities for handling and shipment
 2. Panel Bracing: Suitably brace Panel structure for sufficient strength to support equipment mounted on or within, to withstand handling and shipment, to maintain alignment, and to be rigid and freestanding
 3. Fabricate tops, sides, and rear from minimum 12 gauge (2.7mm) steel plates with stationary rear suitable for back-to-wall installation
 4. Front Doors: use 12 gauge (2.7mm) steel plate, with turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging; of sufficient width to permit door opening without interference with rear projection on flush mounted instruments, essentially fully height, with strong continuous piano type hinges
 5. Positive Latches: Acting from a common door handle that shall hold doors securely compressed at top, side, and bottom against gaskets
 6. Doors shall have padlock locking provisions. All Panels shall be keyed alike
 7. Top and bottom with nominal 1 sq. foot (929 sq. cm) per section removable access plates that shall be drilled to accommodate external wiring and conduit. Arrange Panel internal components for external conduit and piping to enter into the Panel either from above or below
 8. Arrange Panel instruments and control devices in a logical configuration from an Operator's standpoint and as indicated on the Contract Documents
 9. Locate Control Switches and Indicators within 60 inches (1.5m) and 36 inches (0.9m) above the base of the Panel.
 10. Provide duplex, grounded GFI receptacles for service and maintenance tools within the panel at spacing not greater than 5 feet (1.5m) throughout the length of the Panel. Provide lighting and receptacle circuit from a separate power source and fuse separately from the instrument systems
- D. Wall-Mounted Panels

1. Panels: Fabricate the enclosures from not less than 14 gauge (2mm) steel complete with full size gasketed doors with stainless steel three point latch and hinges
2. Construct instrument sub-panels from minimum 1/8 inch (3mm) thick steel, reinforced and braced as required to form a rigid assembly
3. Mount components on easily removable steel sub-panels painted white

2.2 PANEL INSTRUMENTS AND DEVICES

A. General

1. Instruments shall have matching or compatible fascia such as height, finish, color, and display color with a logically grouped panel display
2. Electronic Panel instruments shall be able to operate from 120 VAC plus or minus 10 percent, 60 Hertz (220 VAC +/- 10%, 50 Hz), and 24 VDC plus or minus 10 percent power supply. Instruments in the same panel shall be powered from the same power supply
3. Panel Instruments shall be capable of providing loop power (nominally 24 VDC) for all analog inputs and outputs. Signal circuits and power supply circuits shall be galvanically isolated from each other and the instrument case
4. Operating temperature range shall be from 40 to 120 °F (4.4 to 50 °C) and relative humidity to 90 percent non-condensing

B. Switches

1. Acceptable Manufacturers
 - a. Micro Switch Division of Honeywell, Type PT
 - b. Eaton Corporation
 - c. Culter Hammer Products, Type T
 - d. General Electrical Company, Type CR
 - e. Square D Company, Type K
 - f. Allen-Bradley, Bulletin 800T
2. Selector Switches: Heavy duty oil-type with gloved-hand or wind lever operator. Engrave position legends on switch faceplate. Switches for electrical circuits shall have silver butting or sliding contacts, rate 10 amperes continuous at 120 VAC
3. Contact Configuration: Switches used in electronic circuits shall have contacts with a minimum rating of 2 amperes

C. Indicator Lights

1. Acceptable Manufacturers
 - a. Micro Switch Division of Honeywell, Type PT
 - b. Eaton Corporation
 - c. Culter Hammer Products, Type T
 - d. General Electrical Company, Type CR
 - e. Square D Company, Type K
 - f. Allen-Bradley, Bulletin 800T
2. Heavy-duty, oil-tight type, which utilizes a 6 VDC lamp and built-in transformer. Engrave legends on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the indicating light
3. Integrate a push-to-test feature with each indicating light, or a common test of all Panel Indicating Lights

D. Operator Panels

1. Acceptable Manufacturers
 - a. Optimization, Incorporated, OP-620 Series

- b. Approved Equal
 - 2. Operator Panel shall connect to the PLC, and shall offer two (2) lines of 20 digital characters, plus user definable pushbuttons. Each pushbutton shall have LED indicators
 - 3. The Unit shall display up to 160 user definable status or variable messages
 - 4. The Operator Panel shall operate on 8-30 VDC
 - 5. Communications between the Operator Panel and the PLC shall be via RS232/RS422 4800 to 19200 baud
 - 6. The Unit shall be fully compatible with Allen-Bradley SLC 5-03 products
- E. Control Relays
- 1. Acceptable Manufacturers
 - a. Potter and Brumfield, Series KRP
 - b. Eagle Signal Controls, Series 22 or 80
 - c. Manufacturers of Struthers-Dunn, Incorporated, Series A3 or A4
 - d. IDEC, RH Series
 - 2. Provide Control Relays indicated in Instrument and Control Panels and Enclosures with plug-in socket base type with dustproof plastic enclosures
 - 3. Relays: Relays shall function as indicated on the Contract Documents, in accordance with design requirement, and with not less than the number of poles shown on the Contract Documents. Provide form "C" double-throw contacts
 - 4. Control circuits relays shall have silver-cadmium oxide contacts rated for 10 amperes at 120 VAC
 - 5. Electronic switch-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals
 - 6. Relays utilized for computer input, alarm input, or indicating light service shall have contacts rated not less than 5 amperes
 - 7. Time delay relays shall have dials or switch settings engraved in seconds, with timing repeatability of plus or minus 2.0 percent of setting
 - 8. Provide latching and special purpose relays as indicated for the specific application
 - 9. Relays shall have a built-in lamp, LED or neon, to indicate an energized relay
- F. 7-Day Electronic Digital Time Switch
- 1. Acceptable Manufacturers
 - a. Tork, DIN 200
 - b. Paragon
 - 2. Unit shall program in AM/PM or 24-hour format and shall provide one (1) minute resolution
 - 3. The Unit shall have an LCD display
 - 4. It shall be capable of a minimum of 48 event per channel per week and allow separate schedules for each day of the week
 - 5. The Unit shall have 365 holiday capabilities with 16 single dates and 5 holiday blocks of unlimited duration
 - 6. The Unit shall be selectable between Standard and Daylight Savings Time
 - 7. Controller shall have automatic Leap Year correction
 - 8. Controller shall have a 72 hour memory backup with rechargeable battery
 - 9. The Unit shall be capable of manual override ON or OOF to the next scheduled event using one (1) button for each channel
 - 10. Technical Specification:
 - a. Switching Interval: 1 minute
 - b. Manual Override
 - c. Input Voltage: 120 VAC, 50/60 Hz
 - d. Power Consumption: 5 VA maximum

- e. Battery Backup: 150 hours
- f. Operating Temperature: 14 to 140 °F (-10 to 55 °C)
- g. Accuracy at 68 °F (20 °C): +/- 2.5 seconds per day
- h. Weight: 5.2 oz (147g)
- i. Mounting: DIN Rail (35mm)
- j. Dimensions:
 - i. Width: 1-7/8 inch (48mm)
 - ii. Depth: 2-7/8 inch (73mm)
 - iii. Height: 3-1/4 inch (83mm)
- k. Output:
 - i. Switch Configuration: SPDT
 - ii. Switch Contact Rating: 16 A Resistive

2.3 PANEL ACCESSORIES

A. Terminal Strips

- 1. Acceptable Manufacturers
 - a. Allen-Bradley, 1492-W Line
 - b. Entelelec M4/6 Series
 - c. Weidmuller SAKS
 - d. Phoenix Contact
 - e. Wago
- 2. Voltage Rating: 600 V AC/DC
- 3. Maximum Current: 30 Amperes
- 4. Wire Range: No. 22 – No. 8 AWG
- 5. Density: 38 pieces per foot (125 per meter)
- 6. Insulation Temperature Range: -40 to 221 °F (-40 to 150 °C)
- 7. Color: Gray

B. Plastic Wireway

- 1. Acceptable Manufacturers
 - a. IBOCO Corporation, T1 Duct Series
 - b. Approved Equal
- 2. Material: Rigid PVC, Self-extinguising
- 3. Color: Light Grey or White
- 4. Standard Length: 6 feet 6-3/4 inches (6'-3.75") (2.0m)

C. DIN Mounting Rail

- 1. Acceptable Manufacturers
 - a. IBOCO Corporation
 - b. Approved Equal
- 2. Material: RoHS Compliant, treated with galvanic zinc plating
- 3. Minimum Thickness: 6 microns
- 4. Standard Length: 6 feet 6-3/4 inches (6'-3.75") (2.0m)

2.4 PANEL WIRING

- A. Interconnecting wiring and wiring to terminals for external connection shall be MTW or SIS 16 AWG, stranded copper wire, insulated for not less than 600 volts, with a moisture-resistant and flame-

retardant covering rated for not less than 194 °F (90 °C) except circuits and special instrument interconnecting wiring that shall be in accordance with Manufacturer requirements

B. Panel Wiring Size:

1. Power Distribution Wiring on line side of pane fuses: Minimum 12 AWG
2. Secondary Power Distribution Wiring and Wiring for Control Circuits: Minimum 14 AWG
3. Annunciation and Indicating Light Circuits: Minimum 16 AWG
4. Electronic Analog Circuits within Instrument and Control Panels: Minimum 14 AWG, Twisted and shielded pairs or triads rated not less than 600 volts

C. Analog Circuits and AC Power Circuits: Separated

D. Internal Panel Wire Colors:

1. AC Power Distribution: Red
2. DC Power Distribution: Blue
3. Instrument: Black and White shielded pair

E. Other and in agreement with Manufacturer's wiring diagrams as stated on manufactured drawing legend

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gasket and sealing material under panels with floor slab cutouts for conduit. Undercoat floor mounted panels
- B. Install signal grounding conductor and grounding electrode as required by the Panel Manufacturer
- C. Connect Panel equipment grounding (safety) terminal to the building or facility grounding grid with 6 AWG green insulated conductor

3.2 CLEANING

- A. Clean the interior and exterior of the Panel prior to applying power and energizing

3.3 DEMONSTRATION

- A. Demonstrate operation of equipment in accordance with the intent of the Contract Documents

3.4 PROTECTION

- A. Protect products until acceptance by the Owner

END OF SECTION

SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLER

PART 1 - GENERAL**1.1 SUMMARY****A. This section includes the following:**

1. Programmable Logic Controllers
2. Power Supplies
3. Program Storage
4. General Input and Output
5. Field Wiring Connectors and Terminal Blocks
6. Interfacing and Peripherals
7. Programming Techniques
8. Quality Requirements

B. Related Sections:

1. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
2. SECTION 13 1503 – WATER FEATURE FILTERS
3. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
4. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
5. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
6. SECTION 13 1507 – WATER FEATURE HEATERS
7. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
8. SECTION 13 1509 – WATER FEATURE CHILLERS
9. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
10. SECTION 13 1511 – VALVES, GAUGES, AND METERS
11. SECTION 13 1602 – WATER FEATURE CONTROLS
12. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
13. SECTION 13 1606 – WATER FEATURE INSTRUMENT POWER SYSTEMS
14. SECTION 13 1609 – WATER FEATURE DISCONNECTS, MCC, AND STARTERS
15. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
16. SECTION 26 0000 – ELECTRICAL

C. References:

1. ANSI C37.90A/IEEE 472 – SURGE WITHSTAND CAPABILITY (SWC) TEST
2. NEMA ICS 22-230/3-304-42 – CONDUCT SUSCEPTIBILITY TESTING

1.2 SUBMITTALS FOR REVIEW**A. SECTION 01 3300 – SUBMITTAL PROCEDURES****B. Product Data and Shop Drawings:** Include description of components, methods of connecting components, and the following:

1. Hard copy of the programmable logic controller program with full I/O documentation and explanation of conventions
2. Electronic copy of the programmable logic controller program on portable electronic media

C. Statement of Installation Engineer's Training and Experience: Submit in accordance with requirements for and with Product Data**D. Operating and Maintenance Manuals:** Submit the following information

1. Programming Procedures
2. System Specifications
3. Electrical Power Requirements

4. Application Considerations
5. Explanation of Internal Fault Diagnostics
6. Assembly and Installation Procedures
7. Troubleshooting Procedures
8. Powering Up Procedures
9. Shutdown Procedures
10. Recommend Spare Parts List

1.3 QUALITY ASSURANCE

- A. Provide Programmable Logic Controller (PLC) System components by a single Manufacturer, except for programming computers
- B. Use PLC system Manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps
- C. PLC System Manufacturer Qualifications:
 1. Minimum 10 years prior experience
 2. Capable of providing on-site technical service, including start-up and troubleshooting of equipment
 3. Maintains a 24 hour 7 days a week staffed service center
 4. Provides technical and operational training courses to teach Owner in understanding and applying equipment, including training manuals and "hands on" programming experience on a PLC identical to specified equipment
- D. Programming Installer Qualifications:
 1. Qualified by completion of the PLC Manufacturer's training course
 2. Experience of installing at least five (5) installations equal to scope of project
- E. Provide a single source responsibility for PLC system mounting, installation, and wiring
- F. Design and test the PLC System to operate in an industrial environment per NEMA and IEEE Standards
- G. All PLC software shall be registered and licensed under the Owner's name

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Environmental rating for components of the PLC System, except the programming equipment:
 1. Humidity: Maximum 95 percent, non-condensing
 2. Ambient Temperature:
 - a. Operational: 0 to 60 °C
 - b. Storage: -40 to 80 °C
- B. The PLC System shall be designed and tested to operate in the high electrical noise environment of an industrial plant
- C. Electrical Service: 120 VAC, single phase, 50/60 Hz

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. PLC System: One of the following
 1. Allen Bradley
 2. Approved Equal
- B. Programming Software: PLC – one of the following
 1. Rockwell Software

2. Approved Equal

2.2 PLC SYSTEM DESCRIPTION

- A. PLC System: Underwriter Laboratories listed and CSA approved; Modular, capable of field expansion with additional hardware and software to allow tailoring of the system to process control applications
- B. A major consideration of the PLC System shall be modular, field expandable design allowing the system to be tailored to the customer's machine and/or process control application. The capability shall exist to allow for expansion of the system by the addition of hardware and/or user software
- C. Processor and Input and Output Circuitry: Modular, capable of interchangeability with similar modules to upgrade the system
- D. Modules are defined herein as devices that plug into chassis and are keyed to allow installation in only one direction. The design must prohibit down insertion of the modules. The PLC System must be able to determine the correctness of the module and chassis configuration prior to executing the user program
- E. The PLC shall have downward compatibility whereby all new module designs can be interchanged with all similar modules in an effort to reduce obsolescence
- F. System and Signal Power to the Processor, Interface, and Memory Modules: on a single motherboard or backplane with no interconnecting wiring between modules via plug terminated jumpers
- G. Processor Input and Output Modules: Uniquely numbered so each can be readily identified
- H. Cooling System Modules, and Main and Expansion Chassis: Free air flow convection, without internal fans or other means of cooling, except heat sinks
- I. When PLC losses Outside Electrical Power:
 - 1. Output shall turnoff
 - 2. Internal battery shall provide power to retain user logic, controller configuration information, and data register contents for at least 9 months
- J. Diagnostic LEDs: Capable of indicating major status conditions on the PLC:
 - 1. Upon power-up or power recovery, the PLC shall self-test operation of the microprocessor, check memory for integrity, verify communication between boards, and reset and resume the logic solving scan only when satisfactory
 - 2. During each processing cycle, the PLC shall execute diagnostic routines on critical components with the system. Run-time diagnostics shall determine causes of errors, flag causes, and located failed I/O modules
 - 3. Diagnostic information shall be available to maintenance personnel through the use of a computer based interface or other memory access devices
- K. Memory Capacity: Maximum 75% of design utilization
- L. I/O Handling Capacity: Maximum 75% for each category

2.3 PROCESSOR

- A. A CPU shall be a self-contained unit, and will provide Ladder Rung program execution and support remote or local programming. This device will also supply I/O scanning and inter-processor and peripheral communication functions
- B. The operating system shall be contained in permanently mounted yet reprogrammable devices that allow for easy field upgrades without the need of tools
- C. In a single chassis system all system and signal power to the CPU, support modules shall be distributed on a single motherboard or backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable

- D. The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "Green" indicator when no fault is detected and a "Red" indicator when a fault is detected
- E. All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling
- F. The main chassis front panel shall include indicators showing the following status information:
 - 1. Non-Run or Run mode of the CPU
 - 2. The Fault Status of the CPU
 - 3. Battery Status
 - 4. Communications Status for channels 0 and 1
 - 5. Forces Present/Active
- G. Processor mode shall be selected by a key switch mounted on the front panel of the CPU. The key shall select the following modes:
 - 1. RUN – no ladder edits possible, program always executing
 - 2. PROGRAM – Programming allowed, program execution disabled
 - 3. REMOTE – Programming terminal can make edits and change processor mode
 - 4. TEST – logic executes and inputs are monitored, but output states are not changed
- H. Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shutdown. Only at the time of a hardware change shall this configuration status be altered or re-entered
- I. Upon processor shutdown, outputs shall de-energize and go into a safe shutdown mode
- J. Process Fault Monitoring Section: Capable of providing an indication of the following controller malfunctions:
 - 1. Major Fault in I/O Rack
 - 2. Interrupt Failure
 - 3. I/O Sync Parity
 - 4. Rack Present Fault
 - 5. I/O Parity Error
 - 6. Two I/O Racks given the same number
- K. Minimum Processor Standard Control Functions:
 - 1. Relay Ladder Logic
 - 2. Latch/Unlatch Relays
 - 3. Timers (0.01 second, 0.1 second, and 0.1 minute)
 - 4. Counters (Up/Down)
 - 5. Data Comparisons/Transfers
 - 6. Synchronous Shift Registers (Forward/Reverse)
 - 7. Transitional Output
 - 8. Master Control Relay
 - 9. Bit Read and Control
 - 10. I/O Forcing
 - 11. BCD to Binary and Binary to BCD Conversion
 - 12. Immediate I/O Update
 - 13. Run-Mode Programming
- L. Additional Processor Features:
 - 1. Computer/Network Communication Interface
 - 2. ASCII Output (Data Handling and Report Generation)

3. Protected Logic
4. Proportional Integral Derivative Process Control
5. Multiple Function Integer and Floating Point Math
6. Individual Contact Histogram
7. Conditional Ignore Zone Programming

- M. Processor: Capable of addressing remote I/O modules and multiple I/O chassis up to 5,000 cable feet without additional communication hardware

2.4 POWER SUPPLIES

- A. The PLC shall operate in compliance with an electrical service of either 120 or 240 VAC, single phase, in the frequency range from 47 to 63 Hz, or 24 VDC
- B. The Manufacturer shall be able to provide as standard equipment a system power supply capable of converting AC line power to DC power required to operate the PLC System
- C. A single main power supply shall have the capability of supplying power to the CPU and local Input / Output modules. Auxiliary power supplies shall provide power to each expansion chassis
- D. The power supply shall automatically shutdown the PLC System whenever its output current is detected as being excessive
- E. When the power supply is wired to utilize AC power, the system shall function properly within the range of 85 to 132 or 190 to 260 VAC. The power supply shall provide surge protection, isolation, and outage carry-over of at least 1 cycle of the AC line
- F. In cases where the AC line is especially unstable or subject to unusual variation a voltage regulator shall be installed providing the appropriate constant AC voltage
- G. Design features of the PLC power supply shall include diagnostic indicators mounted in a position to be easily viewed by the user. These indicators shall provide the operator with the status of AC and DC power applied
- H. At the time of power-up, the power supply shall inhibit operation of the processors and I/O modules until the DC voltages are within specification
- I. The power supply shall offer fuse protection

2.5 PROGRAM STORAGE

- A. Program storage medium shall be of a solid state battery backed RAM type
- B. The PLC System shall be capable of addressing up to 16K words, where each word is comprised of 16 data bits
- C. Memory shall be available with 12K with an additional 4K data word segment RAM memory
- D. Battery backed memory shall be capable of retaining all stored program data through a continuous power outage for 24 months under worst case conditions. The capability shall exist to replace the CPU's battery without incurring a loss of user program. A low battery condition must be detectable in ladder logic, but shall not automatically generate a major fault
- E. The PLC System should provide the capability to use EEPROM as a backup for volatile memory up to the full capacity of the controller
- F. The Operator should be able to backup volatile memory, including data and program logic on to a hard disk or USB Flash Memory Device, at their option
- G. All user memory in the processor not used for program storage shall be allocatable from the main memory for the purpose of data storage. The PLC System shall be capable of storing the following data types:

1. External Output Status
 2. External Input Status
 3. Timer Values
 4. Counter Values
 5. Signed Integer Numbers (16 bit)
 6. Binary Numbers
 7. BCD Number
 8. Direct and Indexed Addressing
 9. Internal Processor Status Information
 10. ASCII Character Data
- H. The above listed data types shall be distinguishable to the CPU by the addressing format. Management of the data types into memory subsections shall be an automatic function of the CPU operating system. Any data can be displayed in Binary, Octal, Hexadecimal, Decimal, or ASCII radices. Function-specific data types such as PID, Message, or Processor Status shall have dedicated displays available annotating the meaning of specific control bits and words within them an allowing for selective control where appropriate
- I. If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program
- J. To reduce the effective scan time in order to detest short pulse duration inputs, it shall be possible to program a select logic rung more than once into memory
- K. The number of times a Normally Open (NO) and/or Normally Closed (NC) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions
- L. Ladder logic programs shall have immediate access to the sub-elements of control structures by address and sub-element mnemonic, such as timer accumulator value or timer done bit
- 2.6 GENERAL INPUT AND OUTPUT
- A. Each input or output module shall be a self-contained unit housed within an enclosure
- B. The input/output enclosure (chassis) with it respective modules shall be of a universal type and compatible with several programmable controllers manufactured by the Supplier. Racks shall be sized to accommodate I/O increments of 4, 7, 10, or 13 slots per chassis. A maximum of 13 chassis may be interconnected and directly controlled by the local CPU I/O scan
- C. Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 500 VRMS
- D. It shall be possible to replace any 16 or 32 point input or output module without disturbing field wiring
- E. Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points
- F. All 16 or 32 point and specialty input/output modules shall be color coded and titled with a distinctive label
- G. All input modules shall have a specified filter time constant to limit the effects of voltage transients
- 2.7 FIELD WIRING CONNECTORS AND TERMINAL BLOCKS
- A. I/O Connectors: Attached directly to I/O housings so that modules can be quickly and easily removed without disturbing or flexing the field wiring; with screw terminals
- B. Low and High Density Connectors: Capable of holding two (2) 14 to 22 AWG wires or one (1) 12 AWB wire

- C. Analog Removable Terminal Blocks: Capable of holding two (2) 16 AWG wires or one (1) AWG wire

2.8 INTERFACING AND PERIPHERALS

- A. The programming means shall be an IBM or compatible, portable, or industrial quality programming terminal. The terminal shall include a monochrome or color CRT screen or a color LCD screen and a keyboard for program entry, editing, search, and monitoring functions
- B. The terminal keyboard shall allow for loading of the program format and ASCII characters
- C. The terminal shall be able to function as a stand-alone ASCII (alphanumeric) data terminal with an RS-232-C interface allowing connection to an in-house computer, data terminal, or modem
- D. The programming terminal shall be compatible for interfacing with standard AC electrical service
- E. The terminal shall provide for selecting the communication rate between 100 and 19200 baud for RS-232-C communications
- F. The programming terminal shall be capable of displaying a rung consisting of a maximum of seven (7) series elements and six (6) parallel elements
- G. The programming terminal shall have the capability to be remotely located maximum of 4,000 cable feet (1,200m) from the processor
- H. Each element's status shall be shown independently, regardless of circuit configuration with means of differentiating status conditions
- I. The PLC System shall be able to interface with a data terminal that is RS-232-C compatible (up to 19200 baud) to generate hard copy logic diagrams and/or message generation
- J. The system shall have the capability to interface to portable electronic media and/or hard disk for loading a user program into, or recording the contents of, the processor's memory. It shall be possible to load or record the entire contents or selected portions of memory

2.9 PROGRAMMING TECHNIQUES

- A. The programming format shall be traditional relay ladder diagram
- B. It shall be possible to program a maximum instruction matrix containing as many as 128 instructions
- C. The capability shall exist to change a contact from NO to NC, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung
- D. It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, insofar as there is sufficient memory to accommodate these additions
- E. A single program command or instruction shall suffice to delete an individual ladder diagram rung from memory. It shall not be necessary to delete the rung contact by contact
- F. It shall be necessary to issue a two part command (command and confirmation) in order to delete all relay ladder rungs from memory
- G. A clock/calendar feature shall be included within the CPU. Access to the time and date shall be from the programming terminal, user program, or message generation
- H. Latch functions shall be integral and programmable
- I. The system shall have the capability to address software timers and software counters in any combination and quantity up to the limit of available memory. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming times in the ON or OFF delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment

- J. Timer instructions shall include selectable time bases increments of 1.0 second and 10 milliseconds. It shall be possible to program and display separately the timer's preset and accumulated values
- K. The PLC shall use a signed integer format for data storage of the counter preset and accumulated values
- L. The PLC shall store data as Signed Integer Numbers
- M. The PLC shall have support for minimum integer signed math functions consisting of addition, subtractions, multiplication, division and square root
- N. Instructions shall be provided for grouping contiguous 16 bit data words into a file. The system shall address up to 256 files with up to 256 words per file. File manipulation instructions such as high speed "File Copy" and "Fill Fill", "File to File" move, "Element to File" move, "File to Element" move, and "First In-First Out" shall be supported by the system. The four function math instructions and instructions for performing "Logical OR", Logical AND", "Exclusive OR", and comparison instructions such as "Less Than", "Greater Than", and "Equal To" shall be included within the system. All instructions shall be executed on either single word or files
- O. The system shall contain instructions that will construct synchronous 16 bit word shift registers. Additional instructions shall be provided to construct synchronous bit shift registers
- P. The PLC shall have jump instructions that will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction
- Q. In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions that call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique label. The processor will support nesting of subroutines up to eight levels deep. The program format as displayed on the CRT/LCD screen shall clearly define the main program and all subroutines
- R. The program format shall display all instructions on a CRT/LCD programming panel with appropriate mnemonics to define all data entered by the Programmer. The system shall be capable of providing a "HELP" instruction that when called by the Programmer will display on the CRT/LCD a list of instructions and all data required to enter an instruction into the system memory
- S. At the request of the Programmer, data contained in system memory shall be displayed on the CRT/LCD programming panel. This monitoring feature shall be provided for input/output status, timer/counter data, files, and system status. Ladder logic rungs shall be displayed on the CRT/LCD with rung numbers in sequential order
- T. The system shall have the capability to enter rung comments above ladder logic rungs. These comments may be entered at the same time the ladder logic is entered
- U. The capability shall exist for adding, removing, or modifying ladder logic rungs during program execution. When changes to ladder logic are made or new logic rungs are added, it shall be possible to test the edits of such rungs before removal of prior logic rung is executed
- V. Manual set (Force ON or OFF) shall be possible for hardwired input or output points or analog values from the CRT/LCD programming panel or the main chassis front panel. Removal of these forced I/O points shall be possible either individually or globally through selected keystroke. The programming terminal shall display force I/O points
- W. A means to program a fault recovery routine shall exist. When a major system fault occurs in the system, the fault recovery routine shall be executed and to determine if the fault has been eliminated. If the fault is eliminated, the program resumes. If the fault still exists, the system remains shutdown.
- X. An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified millisecond range. This routine must be able to close any asynchronous control loop consisting of input points, output points, contact/coils, math instructions, circular comparison (limit) instructions

- Y. The programming software shall have the ability to program ladder logic via symbols from a global database
 - Z. An instruction shall be supported to incorporate close loop control systems. The “Proportional”, “Integral”, and “Derivative” elements shall be accessible to the user in order to tune a closed loop system
 - AA. The CPU shall support indexed addressing of inputs and outputs, along with all data tables words (integer, binary, timers, and counters) for the software instruction set
 - BB. The system shall support both bit and word level diagnostic instructions
 - CC. Output instructions shall include a “One Shot” instruction that may be triggered on the low-to-high (rising) rung condition
 - DD. The processor shall support Master Control Reset (Relay) type functionality to selectively disable sections of relay ladder logic
 - EE. An interrupt routine shall be programmable such that routines shall be executed base upon the input conditions of up to eight (8) discrete hardware inputs in the processor chassis. The routine will be executed within 500 microseconds of the detection of the input signals. The eight (8) inputs will be repetitively examined or scanned within a 100 microsecond time period
- 2.10 QUALITY REQUIREMENTS
- A. The programmable controller processor shall be able to withstand conducted susceptibility tests as outlined in NEMA Standards

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Examine surfaces, substrates, and conditions for compliance with requirements of other sections in which related work is specified, and determine if surfaces, substrates, and conditions affecting the performance of the Work of this section are satisfactory. Do not proceed with the Work of this section until unsatisfactory conditions have been corrected in a manner acceptable to the Installer. Starting installation constitutes acceptance of surfaces, substrates, and conditions

3.2 FIELD QUALITY CONTROL

- A. Perform conducted susceptibility (RFI, EMI) test as outlined in NEMA, ANSI and IEEE Standards
- B. Subject completed PLC units to a burn-in test at 60 °C for at least 96 hours

3.3 DEMONSTRATION

- A. Establish a mutually agreed upon time for demonstrations with the Engineer/Programmer
- B. Deliver written notification of demonstrations to the Engineer/Programmer at least seven (7) days before the demonstrations. Include an agenda for the demonstration and testing procedures with the notification
- C. Demonstrate functional operation of the PLC System hardware and logic program at system assembly location prior to shipment
- D. Demonstration full functional operation of the PLC System hardware and logic program at the job site when fully integrated to the field I/O's.

END OF SECTION

SECTION 13 1608 – WATER FEATURE LIGHTING AND CONTROLS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes the following:
 - 1. Circuit Breakers
 - 2. Lighting Contactors
 - 3. Low Voltage Transformers
- B. Related Sections:
 - 1. SECTION 13 1602 – WATER FEATURE CONTROLS
 - 2. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
 - 3. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
 - 4. SECTION 26 0000 – ELECTRICAL
- C. References:
 - 1. NEMA ICS 2-211B
 - 2. NFPA 70 – National Electrical Code (NEC), Article 680
 - 3. Underwriters Laboratories (UL)

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's literature, cut sheets indicating mounting instructions, dimensions, materials, electrical requirements, and operational parameters
- C. Warranty: Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer.

PART 2 - PRODUCTS**2.1 CIRCUIT BREAKERS**

- A. Provide Ground Fault Circuit Breakers (GFCI) for all underwater lighting circuits as shown on the Contract Documents
- B. Provide devices of the voltage and ampacity as shown on the Contract Documents

2.2 LIGHTING CONTACTORS

- A. Acceptable Manufacturers
 - 1. Square D Company, Class 8903, Type S
 - 2. Cutler-Hammer
 - 3. Approved Equal
- B. The Contactor shall switch a load at 120/230 VAC, 60/50 Hz and shall have the number of poles shown in the Contract Documents
- C. The Contactor shall be continuously rated for 20 amperes per pole for all types of ballast and tungsten lighting, resistance, and motor loads

- D. The Contactor shall have a totally enclosed, double-break silver-cadmium-oxide power contacts.
 - 1. Auxiliary arcing contacts are not acceptable.
 - 2. Contact inspection and replacement shall be possible without disturbing line or load wiring.
 - E. The Contactor shall have straight-through wiring with all terminals clearly marked
 - F. The Contactor shall be approved per UL 508 and/or CSA, and be designed in accordance with NEMA ICS 2-211B. They shall be industrial-duty rated for applications to 600 volts maximum
 - G. The Contactor shall have provisions for factory or field addition of the following:
 - 1. Four (4) N.O. or N.C. auxiliary contacts rated for 6 amperes continuous at 600 VAC
 - 2. Single or double circuit, N.O. or N.C., 30 or 60 amperes 600 volt power-pole adder
 - 3. Control-circuit fuse holder, one (1) or two (2) fuses
 - 4. Transient-suppression module for control circuits of 120 volts
 - H. The Contactor shall be electrically held, and shall be continuously rated to be totally encapsulated
- 2.3 LOW VOLTAGE TRANSFORMER
- A. Approved Manufacturers
 - 1. Hydrel, Series 1900
 - 2. Intermatic, PX100, PX300, & PX600 Series
 - 3. Approved Equal
 - B. The Transformer shall be UL Listed and meet the requirements of NEC Article 680
 - C. The Transformer shall be suitable for wall mounting, in a damp location
 - D. The Transformer shall provide an integral primary circuit breaker
 - E. The Transformer shall have a primary voltage of 120/230 VAC and a secondary voltage of 12 VAC and provide taps to ensure proper lamp voltage after line losses
 - F. The Transformer shall provide adequate room for termination of both primary and secondary wiring enclosed in the transformer enclosure
 - G. The Transformer shall be rated for continuous use.

PART 3 - EXECUTION**3.1 CIRCUIT BREAKERS**

- A. Install circuit breakers on all circuits feeding underwater lighting circuits
- B. Provide any additional provisions to meet local codes and requirements

3.2 LIGHTING CONTACTORS

- A. Install Lighting Contactors in an enclosure according to SECTION 13 1605 – WATER FEATER CONTROL PANELS
- B. Provide HAND-OFF-AUTO control switches for each controller, such that in HAND the contactor is closed, in OFF no control is allowed, and in AUTO control shall be determined by a separate contact closure, or as shown in the Contract Documents
- C. Provide adequate room in the enclosure for two (2) additional lighting contactors

3.3 LOW VOLTAGE TRANSFORMERS

- A. Install Low Voltage Transformers as shown on the Contract Documents
- B. Size the Transformer as shown on the Contract Documents
- C. Size the Conductor from the Transformer to the light fixture such that the voltage drop, at full load, will not exceed 0.5 volts per lamp
- D. Install the Transformer in a location that will not have moisture directly falling on to the unit. Install the unit at least 1/4 inch (6mm) away from the wall
- E. Install all Conductors to/from the Transformer in flexible conduit with appropriate fittings.
- F. All conduit runs from the underwater fixture to the Transformer shall be water tight
- G. Comply with all local codes and requirements for installation

END OF SECTION

SECTION 13 1609 – WATER FEATURE DISCONNECTS, MCC, AND STARTERS

PART 1 - GENERAL**1.1 SUMMARY**

- A. This section includes the following:
 - 1. Disconnect Switches
 - 2. Motor Control Centers (MCC)
 - 3. MCC Components, including Motor Starters, SSVR, and VFD Controllers
- B. Related Sections:
 - 1. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 2. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 3. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
 - 4. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
 - 5. SECTION 13 1507 – WATER FEATURE HEATERS
 - 6. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
 - 7. SECTION 13 1509 – WATER FEATURE CHILLERS
 - 8. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
 - 9. SECTION 13 1511 – VALVES, GAUGES, AND METERS
 - 10. SECTION 13 1602 – WATER FEATURE CONTROLS
 - 11. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
 - 12. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS
 - 13. SECTION 13 1608 – WATER FEATURE LIGHTING AND CONTROLS
 - 14. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
 - 15. SECTION 26 0000 – ELECTRICAL
- C. References:
 - 1. NEMA 250 – Enclosures for Electrical Equipment
 - 2. NEMA ICS 18 – Industrial Control and Systems: Motor Control Centers
 - 3. NEMA KS 1 – Enclosed Switches
 - 4. NFPA 70 – National Electrical Code (NEC)
 - 5. Underwriters Laboratories (UL) 98 – Enclosed and Dead Front Switches
 - 6. UL 845 – UL Standard for Safety of Motor Control Centers

1.2 SUBMITTALS FOR REVIEW

- A. SECTION 01 3300 – SUBMITTAL PROCEDURES
- B. Product Data: Submit Manufacturer's literature for all major components including but not limited to the following: Motor starters, overload relays, circuit breaker and fuse information, control power transformers, pilot devices, relays, and etc
- C. Shop Drawings: Submit Manufacturer drawing showing the following:
 - 1. Layout and configuration of the MCC, including height, width, depth, and location of shipping splits
 - 2. Structure descriptions showing: Bus rating, enclosure rating, short-circuit withstand rating, and other information requiring approval
 - 3. Conduit Locations
 - 4. Required Bus Splices
 - 5. Unit Descriptions including starter sizes, circuit breaker frame sizes, circuit breaker continuous amperage rating, pilot devices, etc
 - 6. Nameplate information
 - 7. Schematic Wiring Diagrams

- D. Provide a copy of the Manufacturer's installation instructions that include the following: Delivery and storage instructions, general description for reading nameplate data and other markings, installation procedures, conduit and cable installation, installing and removing plug-in units, operation of operator handles and unit interlocks, checklist before energizing, procedure for energizing equipment, and maintenance procedures
- E. Warranty: Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer.

1.3 DESIGN REQUIREMENTS

- A. Provide MCC base upon applicable NEMA and UL Standards and in accordance with the details Contract Documents
- B. The Manufacturer of the MCC shall also be the Manufacturer of the across-the-line motor starters, across-the-line contactors, solid-state reduced voltage starters, and variable frequency drives.
- C. The Contractor shall confirm the motor full-load amperage ratings and provide those to the MCC Manufacturer to ensure proper sizing of the motor branch circuit and overload protection

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with the Manufacturer's instructions
- B. One (1) copy of the Manufacturer's instructions shall be included with the equipment at time of shipment

1.5 REGULATORY REQUIREMENTS

- A. The MCC shall bear a UL Label and shall conform to the requirements of the latest edition of the NEC and/or other applicable installation standards
- B. The Manufacturer shall provide certified copies of production test reports demonstrating compliance when requested by the Engineer

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Approved Manufacturers
 - 1. Schneider Electric – Square D Company
 - 2. Eaton
 - 3. Approved Equal
- B. Switch Interior
 - 1. All switches shall have switch blades that are visible when the switch is OFF and the cover is open
 - 2. Lugs shall be UL Listed and sized for the temperature and amperage ratings as recommended by the Manufacturer, aluminum or copper
 - 3. All current carrying parts shall be plated to resist corrosion
- C. Switch Mechanism
 - 1. The Switch operating mechanism shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started
 - 2. The operating handle shall be an integral part of the box, on the cover
 - 3. Provisions shall be provided for padlocking the switch in the OFF position
- D. Switch Enclosures

1. The enclosure shall be NEMA Type 1 for dry indoor use and NEMA Type 3R for outdoor or high humidity environments
 2. Tangential knockouts shall be provided to facilitate ease of conduit entry on switches through 200 ampere
 3. Enclosures for Type 3R switches through 200 ampere shall have provisions for interchangeable bolt-on hubs in the top endwall. Hubs shall be provided by a common manufacturer
- E. Switch Ratings
1. Switches shall be horsepower rated for 240 VAC as indicated on the Contract Documents
 2. The UL Listed short circuit rating shall be as per the Manufacturer's recommendation and specification
- 2.2 MOTOR CONTROL CENTERS (MCC)
- A. Approved Manufacturers
1. Allen-Bradley
 2. Siemens Energy and Automation
 3. Eaton / Cutler Hammer
 4. Approved Equal
- B. Ratings
1. The MCC shall be 600 volt class suitable for operation on a three-phase, 50/60 Hz system.
 2. The MCC shall be rated for the system voltage as indicated on the Contract Documents
 3. The MCC horizontal and vertical power bus bracing shall be rated to meet or exceed the available fault current as shown on the Contract Documents
 4. All MCC units shall have a full rated short-circuit rating that meets or exceeds the available fault current as shown on the Contract Documents
 5. All circuit breakers used in the MCC shall have full-rated short-circuit interrupt ratings based on the applied MCC voltage
- C. Enclosure
1. The MCC enclosure shall be NEMA Type 2 for indoor installation and NEMA Type 3R for outdoor installations
 2. Each section shall be equipped with two (2) full metal side sheets to isolate each vertical section and to help reduce the likelihood of fault propagation between sections
 3. All interior and exterior surfaces shall be painted ANSI 49 medium light gray. The vertical wireways and unit back plates shall be painted high visibility gloss white
 4. All unpainted parts shall be plated for corrosion resistance
 5. Removable closing plates on each end of the MCC shall cover all horizontal bus and horizontal wireway openings
 6. Insulating sheets shall be provided on the inside of the end closing plates for horizontal openings to help prevent burn-through of the end closing plate in the event that the internal arcing fault occurs in the horizontal bus compartment
- D. Structure
1. The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units
 2. Vertical Sections shall be rigid, free-standing structures
 - a. Vertical sections shall have internal mounting angles running continuously within the shipping block. An external mounting channel that is required to maintain structure integrity is not acceptable

- b. Vertical sections shall be 90 inches (2.3m) high, 20 inch (500mm) wide, and either 15 inch (380mm) or 20 inches (500mm) deep as required. Custom widths shall be available
 - c. Vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block. Lifting eyes are not acceptable
 - d. Each standard section shall be capable of being subdivided into 12 usable, unit spaces
 - e. Two (2) unit spaces shall constitute one (1) space factor and shall be 13 inches (325mm) in height
 - f. One (1) unit space shall constitute one-half space factor and shall be 6.5 (165mm) in height
- 3. Horizontal Wireways
 - a. Horizontal wireways shall be located at the top and bottom of the MCC
 - b. Horizontal wireways shall be 6 inches (150mm) in height and extend the full depth of the vertical section to allow maximum flexibility in locating conduit for MCC feeds and loads
 - i. Pull boxes to extend the height of the top horizontal wireway by 12 inches (300mm) shall be provided, if specified
 - c. Horizontal wireways shall be continuous across the length of the MCC, except where access needs to be denied due to electrical isolation requirements
 - d. The horizontal wireways shall be isolated from the power bus
 - e. The horizontal wireways shall have removable covers held in place by captive screws
- 4. Provide a full height vertical wireway, independent of the plug-in units, in each standard vertical section
 - a. The vertical wireway shall be isolated from the vertical and horizontal buses
 - b. The vertical wireway shall be covered with a hinged and secure door
 - c. Wireway tie bars shall be provided
 - d. Isolation between the wireway and the units shall be provided with arc resistant latches to help keep the door latched in the event that the internal arcing fault occurs
- 5. All full voltage starter units through NEMA Size 5 and all feeder breakers through 400 amperes shall be of the draw-out type. Draw-out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw-out units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend outside of the draw-out unit. Units equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. In addition, a master terminal block, when Type C wiring is specified, shall be draw-out and shall be located in the top wireway, readily accessible through a hinged cover. All control wire to be 14 AWG minimum
- 6. All draw-out units shall be secured by a spring-loaded, quarter turn, indicating type fastening device located at the top front of the unit. With the exception of the dual-mounted units, each unit compartment shall be provided with an individual front door
- 7. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access, unless the disconnect switch is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect switch. A second interlock shall be provided to prevent removal or reinsertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect switch in the OFF position with up to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus
- 8. Doors are to be hinged in a manner that allows for the removal of the individual doors without the removal of any door above or below. Unit doors shall be hinged on the left and vertical wireway doors on the right for unobstructed access to the units and associated vertical wireway.

All doors shall be mounted on removable pin-type hinges and secured with steel quarter turn, indicating type fasteners

9. MCC's shall be assembled in such a manner that it is not necessary to have rear accessibility to remove any internal device or components

E. BUS BAR

1. Horizontal Power Bus

- a. The horizontal bus shall be rated as shown on the Contract Documents
- b. The horizontal bus material shall be copper with tin plating
- c. The horizontal bus shall be supported, braced and isolated from the vertical bus with a high strength, non-conductive, non-tracking, glass polyester material
- d. For standard sections the horizontal bus shall be continuous within each shipping block and shall be braced within each section
- e. Horizontal bus splices shall have at least two (2) bolts on each side

2. Vertical Bus

- a. The vertical power bus shall have an effective rating of 600 amperes. If a center horizontal bus construction is utilized, then the rating shall be 300 amperes above and below the horizontal bus for an effective rating of 600 amperes
- b. The vertical bus material shall be copper with tin plating
- c. The vertical bus shall be attached to the horizontal bus with at least two (2) bolts
- d. The vertical bus shall be continuously braced by a high strength, non-conductive, non-tracking, glass-filled polyester material and isolated from the unit spaces by a non-conductive, polycarbonate molded cover
- e. Automatic shutters shall cover plug-in stab openings when the units are removed

3. Ground Bus

- a. Provide a ground bus system consisting of a horizontal ground bus connected to vertical ground buses mounted in each section
- b. Provide a tin-plated copper, 1/4 x 1 inch (6 x 25mm) or 1/4 x 2 inch (6 x 50mm) horizontal ground bus mounted in the bottom of the MCC unless otherwise specified in the Contract Documents
- c. Provide a pressure-type mechanical lug mounted on the ground bus in the incoming line section
- d. Provide a unit ground stab on all unit inserts. The ground stab shall establish unit insert grounding to the vertical ground bus before the plug-in power stabs engage the power bus. The grounding shall be maintained until after the plug-in power stabs are disengaged

4. Neutral Bus

- a. In a 4-wire system with a main incoming device rated at 400 amperes or less, if there are not neutral loads in the MCC, an incoming neutral termination plate in the MCC main device unit is acceptable in lieu of a horizontal neutral bus
- b. In a 4-wire system with a main incoming device rated at more than 400 amperes, if there are no neutral loads in the MCC, an incoming neutral termination plate in the MMC main device unit connected to a horizontal neutral bus in the section with the main is acceptable
- c. If neutral loads are specified within the MCC, provide neutral connection plates in sections with horizontal neutral bus as indicated on the Contract Documents
- d. Horizontal neutral bus shall be provided in the main incoming and adjacent sections as specified in the Contract Documents
- e. Neutral bus rating shall be the same as the horizontal power bus rating

F. MCC Communications Options

1. MCC shall be able to provide at least one (1) of the following methods of communication:
 - a. FIELDBUS Devices
 - b. DEVICENET Devices
 - c. PROFIBUS Devices
 - d. MODBUS TCP Devices
 - e. MODBUS Serial Devices
 - f. ETHERNET/IP Devices
2. Provide communications option when specified in the Contract Documents

2.3 MCC COMPONENTS

A. Unit Information

1. The minimum compartment height shall be 6.5 inches (165mm) and this shall be considered one-half space factor
2. NEMA Size 5 FVNR starters and below shall be provided as plug-in units
3. Plug-in Units
 - a. Plug-in Units shall consist of a unit assembly, unit support pan, and unit door assembly
 - b. Units shall be supplied with removable doors. The unit doors shall be fastened to the structure so that the doors can be closed with the unit is removed
 - c. A unit support pan shall be provided for support and guiding units. Unit support pans shall remain in the structure when units are removed to provide isolation between units
 - d. A service position shall be provided for plug-in units that allows for the unit to be supported, but disengaged from the bus. The unit shall be capable of being padlocked in the service position. This position is to be used to isolate a unit from the bus to allow service to be performed on the connected load equipment
4. Power Stabs
 - a. Unit stabs for engaging the power bus shall be tin-plated copper and provided with stainless back-up springs to provide and maintain a high pressure 4-point connection to the vertical bus
 - b. Wiring from the unit disconnecting means to the plug-in stabs shall not be exposed on the rear of the unit. A separate isolated pathway shall be provided for each phase to minimize the possibility of unit fault conditions reaching the power bus system
 - c. The power cable termination at the plug-in stab shall be maintenance-free crimp type connection
5. Withdrawable Power Stabs
 - a. Plug-in units shall have the capacity of withdrawing the power stabs, allowing the primary voltage to be disconnected with the unit door closed
 - b. The Withdrawable assembly shall accept a standard 1/4 inch (6mm) hex-style drive socket
 - c. The Withdrawable stabs design shall include a set of stab assembly-mounted shutters
 - d. The Withdrawable stabs design shall include interlock mechanisms
 - e. The Withdrawable stabs design shall include feedback mechanisms that are verifiable with the unit door closed
 - f. The Withdrawable power stabs with the door closed mechanism shall not increase the original height design so total space in the MMC is optimized
 - g. A remote operating device shall be supplied to allow the connection and disconnection of the power stabs with the doors closed
6. Disconnect Handle
 - a. Plug-in units shall be provided with a heavy-duty, non-conductive, industrial-duty, flange mounted handle mechanism for control of each disconnect switch or circuit breaker

- b. Use of rotary operators is not acceptable
 - c. The disconnect handle may pivot in the vertical or horizontal plane
 - d. The ON-OFF condition shall be indicated by the handle position, red and green color indicator with the words ON and OFF, and the international symbols 1 and 0 along with a pictorial indication of the handle position
 - e. Handles shall be capable of being locked in the OFF position with up to three (3) padlocks
 - f. Plug-in units shall be provided with interlocks per NEMA and UL requirements
- 7. Pilot Devices
 - a. Where specified, units shall be furnished with pushbutton, selector switches, or pilot lights as shown on the Contract Documents
 - b. Pilot devices shall be rated NEMA Type 4/13 water tight/oil tight
- 8. Terminal Blocks
 - a. Control Terminal blocks shall be provided on all contactor and starter units. They shall be a pull-apart design on all plug-in units for easy removal of the unit from the structure
 - b. Control terminal blocks on non-plug-in contactor and starter units shall be fixed type
 - c. Power terminal blocks shall be provided on all contactor and starter units, rated NEMA Size 3 (100 amperes) and below that utilize vertically operated disconnects
 - d. Terminal blocks shall not be located adjacent to or inside the vertical wireway
- 9. Doors
 - a. Each unit shall be provided with a removable door mounted on removable pin-type hinges
 - b. The unit doors shall be capable of being opened at least 110 degrees
 - c. The unit doors shall be removable from any location in the MCC without disturbing any other unit doors
 - d. The unit doors shall be fastened to the structure so it can be closed to cover the unit space when the unit is removed
 - e. The unit doors shall be held closed with quarter-turn latches
 - f. Unit door latches shall be provided with arc resistant latches the help keep the door latched in the event that an internal arcing fault occurs
- B. Metering Compartment
 - 1. The MCC shall include a plug-in metering unit
 - 2. The unit shall include the following
 - a. Fusible disconnect with fuses. The disconnect must be operable with the unit door closed
 - b. Fused control circuit transformer
 - c. Current transformers shipped loose to be installed by the Contractor onto incoming power conductors
 - d. Solid-state power monitor with door mounted display
 - 3. Power Monitor
 - a. The power monitor shall be capable of displaying the following:
 - i. Line current for all three phases with plus or minus 0.2 percent full-scale accuracy
 - ii. Average three phase current with plus or minus 0.2 percent full-scale accuracy
 - iii. Line-to-neutral and line-to-line voltage with plus or minus 0.2 percent full-scale accuracy
 - iv. Current and voltage unbalance
 - v. Real, reactive, apparent and true power with plus or minus 0.4 percent full-scale accuracy
 - vi. kWh, kVARh, and kVAHnet
 - vii. True RMS to the 45th harmonic

- viii. Frequency at plus or minus 0.5 percent
 - ix. Power factor at plus or minus 0.4 percent
 - b. The power monitor shall include min/max logs and trend logs with up to 45,867 data points
 - c. The power monitor shall be capable of performing distortion analysis with THD, Crest Factor (I, V) and Distortion power factor
 - d. The power monitor shall include a communication port compatible with specified communication option
 - e. The power monitor shall include two (2) form-C relays
- C. Disconnects
- 1. Main Disconnect
 - a. If no overcurrent protection is indicated, provide a main incoming-line lug compartment. Lugs to accommodate the incoming power conductors as indicated on the Contract Documents
 - b. Main Fusible Disconnect Switch (if specified in the Contract Documents) provide as per Manufacturer specification
 - c. Main Circuit Breaker Disconnect (if specified in the Contract Documents) provide as per Manufacturer specification
 - 2. Feeder Disconnects and Transformer Disconnects
 - a. The disconnecting means for feeders and transformers shall be circuit breakers with thermal-magnetic trip units for 400 amps and smaller frames; provide an electronic trip unit for 600 amps and larger frames
 - b. The interrupting capacity rating shall meet or exceed the available fault current as shown in the Contract Documents
 - c. The minimum frame sizes shall be 150 amps
 - d. Provide one (1) normally open and one (1) normally closed circuit breaker auxiliary contact which follows the position of the circuit breaker main contacts for indication of ON or OFF/Tripped
 - 3. Motor Starter Disconnect
 - a. Electro-mechanical NEMA Starters
 - i. The disconnecting means for the across the line starters shall be motor circuit protectors
 - ii. The unit short circuit rating shall be greater than or equal to the available fault current as shown on the Contract Documents
 - iii. Units shall be supplied base upon the rules/requirements set for in the UL 845, NEMA ICS-18, and NFPA 70
 - iv. Units shall be shipped as the motor circuit protector set as lowest setting per UL Standards. The Contractor shall field adjust the units based upon the particular motor application
 - v. The minimum frame size shall be 150 amps
 - vi. Provide one (1) normally open and one (1) normally closed circuit breaker auxiliary contact which follows the position of the circuit breaker main contacts for indication of ON or OFF/Tripped
 - b. Solid State Controllers (solid-state reduced voltage motor controllers (SSRV) and variable frequency drives (VFD))
 - i. The disconnecting means for solid-state controllers shall be fusible disconnect with current limiting fuses

- ii. The short circuit rating shall be 100,000 amps (RMS symmetrical)
- D. Automatic Transfer Switch
 - 1. Provide if specified in the Contract Documents
- E. Combination NEMA Rated Across The Line Starters
 - 1. Starters shall meet applicable NEMA and UL requirements
 - 2. Starters shall be minimum NEMA 1. Fractional NEMA sizes are not acceptable
 - 3. Starters shall be provided with a 3-pole solid state overload relay that includes the following features:
 - a. Communication capability, which takes precedence over this overload requirement
 - b. Selectable trip classes of 10, 15, 20, or 30
 - c. Set for class 20 unless otherwise indicated on the Contract Documents
 - d. Overload Protection
 - e. Phase Loss Protection
 - f. Trip Current adjustment range of 5:1
 - g. Test/Reset Button
 - h. Bipolar latching relay with one (1) normally open and one (1) normally closed contact, rated NEMA B600 for use in motor contactor control circuits
 - i. Thermal memory circuit to model the heating and cooling effects of motor ON and OFF periods
 - j. If ground fault protection is required, it shall have selectable trip value between 20 mA and 5 A
 - 4. The starter shall be capable of accommodating up to six (6) contacts in addition to the hold-in contact
 - 5. Provide a control power transformer with a rated secondary voltage of 120 VAC. The control power transformer shall be provided with primary and secondary fusing
 - 6. Overload relays shall have a reset button located on the outside of the unit door
 - 7. Provide a door mounted selector switch for HAND-OFF-AUTO operation. The HAND mode shall provide local control at the MCC unit door. The AUTO mode shall provide control through a remote contact
 - 8. Provide door mounted 120 VAC push-to-test pilot lights with LED lamps for ON (RED) and OFF (GREEN) status indication
- F. SSRV Motor Controllers
 - 1. Provide a control power transformer with a rated secondary voltage of 120 VAC. The control power transformer shall be provided with primary and secondary fusing
 - 2. Type 1 SSRV Controller
 - a. Integrated bypass contactor that is closed once the motor is up to full speed
 - b. Electronic overload protection with adjustable trip class
 - c. Four (4) programmable auxiliary contacts
 - d. Selectable control capabilities: soft start, kick start, current limit start, dual ramp, full voltage, linear speed, preset slow speed, soft stop
 - e. Additional control capabilities, as available from specific Manufacturer
 - f. LCD display
 - g. Keypad programming for configuration
 - h. Built-in, selectable protective functions for: overload, jam, stall, excessive starts per hour, underload, over/under voltage, voltage unbalance
 - i. Metering capabilities for: Current, voltage, kW, kWH, power factor, motor thermal capacity utilized, elapse time
 - j. Ground Fault protection (1 A to 5 A)

3. Type 2 SSRV Controller
 - a. Integrated bypass contactor that is closed once the motor is up to full speed
 - b. Electronic overload protection with adjustable trip class
 - c. Selectable control capabilities: soft start, kick start, current limit start, soft stop
 - d. Built-in, selectable protective functions for: overload, phase reversal, phase Loss/Open Load, Phase imbalance, shorted SCR, SCR Over temperature
 4. Provide an input isolation contactor
 5. The Type 2 Unit shall be provided with line side protective modules. The modules shall contain capacitors and metal oxide varistors (MOVs) that protect the internal power circuitry from severe electrical transients and/or high electrical noise
 6. Provide door-mounted pilot devices as shown on the Contract Documents
 7. Provide door mounted 120 VAC push-to-test pilot lights with LED lamps for ON (RED) and OFF (GREEN) status indication
 8. Emergency run bypass contractor is required. Bypass shall be fully rated for the motor load and be capable of starting the motor at full voltage. The emergency run bypass shall be provided with the same type of solid-state overload relay protection as for the electromechanical starter units
- G. VFD Motor Controller
1. Provide a control power transformer with a rated secondary voltage of 120 VAC. The control power transformer shall be provided with primary and secondary fusing
 2. Provide door-mounted pilot devices as shown on the Contract Documents
 3. Provide door mounted 120 VAC push-to-test pilot lights with LED lamps for ON (RED) and OFF (GREEN) status indication
 4. Provide a door-mounted human interface module for programming, display and control
 5. Provide on isolated, configurable analog input and output
 6. Provide additional Manufacturer recommended options for the application specified.

PART 3 - EXECUTION

3.1 DISCONNECT SWITCH INSTALLATION

- A. Clearly label Disconnects with the equipment served. Use 1/16 inch (2mm) thick laminated plastic composition material with contrasting color core. Engraved lettering shall be 1/4 inch (6mm) high. Attach tags with screws
- B. Install Disconnect Switch when motors are not in sight of the MCC.

3.2 MCC INSTALLATION

- A. The Contractor shall install the MCC in accordance with the Manufacturer's instructions
- B. The Contractor shall tighten all accessible bus connections and mechanical fasteners to the Manufacturer's torque requirements
- C. The Contractor shall select and install all fuses in fusible switches based upon field requirements
- D. The Contractor shall adjust circuit breaker settings based upon field requirements
- E. The Contractor shall adjust solid state overloads to match the installed motor characteristics
- F. The Contractor shall provide field reports on tests performed, test values experienced, etc. and make the report available to the Owner upon request
- G. The Contractor shall perform field adjustment of the short circuit and overload devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device evaluation study, protective device coordination study, manufacturer's instruction leaflet, and the Contract Documents

- H. The Manufacturer of the MCC shall be capable of providing the programming for the PLC and the operator interface, if provided with the MCC
- I. The Manufacturer shall be capable of providing start-up services as part of the supply of the MCC
- J. The Manufacturer shall provide training for the Operator, which covers concepts and knowledge to install, troubleshoot the MCC and associated programming
- K. Clearly label MCC units with the equipment being served. Use 1/16 inch (2mm) thick laminated plastic composition material with contrasting color core. Engraved lettering shall be 1/4 inch (6mm) high. Attach tags with screws

END OF SECTION

SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES

PART 1 - GENERAL**1.1 SUMMARY****A. This section includes the following:**

1. Raceways
2. Wires and Cables
3. Boxes
4. Wiring Devices
5. Supporting Devices and Hangers

B. Related Sections:

1. SECTION 13 1601 – WATER FEATURE GENERAL ELECTRICAL REQUIREMENTS
2. SECTION 13 1602 – WATER FEATURE CONTROLS
3. SECTION 13 1603 – WATER FEATURE SCADA CONTROL
4. SECTION 13 1604 – WATER FEATURE FIELD INSTRUMENTS, SWITCHES, AND ALARMS
5. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
6. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS
7. SECTION 13 1608 – WATER FEATURE LIGHTING AND CONTROLS
8. SECTION 13 1609 – WATER FEATURE DISCONNECTS, MCC, AND STARTERS
9. SECTION 13 1611 – WATER FEATURE GROUNDING
10. SECTION 26 0000 – ELECTRICAL

C. References:

1. NFPA 70 – National Electrical Code (NEC)
2. Underwriters Laboratories (UL)

1.2 SUBMITTALS FOR REVIEW**A. SECTION 01 3300 – SUBMITTAL PROCEDURES**

- B. Product Data:** Submit Manufacturer's literature, cut sheets indicating mounting instructions, sensor dimensions, materials, electrical requirements, and operational parameters
- C. Warranty:** Submit manufacturer's warranty and ensure forms have been completed in the owner's name and registered with the manufacturer.

PART 2 - PRODUCTS**2.1 RACEWAYS****A. Conduit**

1. 1/2 inch (15mm) minimum diameter unless indicated otherwise and used strictly as indicated by product. If not indicated on the Contract Documents, size conduit for conductor type and quantity installed
2. Galvanized Rigid Steel or Galvanized Intermediate Metallic Conduit (IMC)
 - a. May be used in all areas
3. Galvanized Electrical Metallic Tubing (EMT)
 - a. May be used in indoor dry locations where it is:
 - i. Not subject to damage
 - ii. Not in contact with earth
 - iii. Not in concrete

-
4. Schedule 40 Polyvinyl Chloride (PVC)
 - a. May only be used
 - i. Underground
 - ii. In or below concrete
 - b. Use Galvanized Rigid Steel elbows and risers wrapped with approved protection tape
 5. Flexible Steel Conduit
 - a. 3/4 inch (20mm) minimum
 - b. Required for final connections to indoor mechanical equipment, length not to exceed 36 inches (1m)
 6. Listed, Liquid-Tight Flexible Metallic Conduit
 - a. Use in outdoor final connections to mechanical equipment, not to exceed 36 inches (1m) with ground conductor
 - B. Fittings
 1. Compression type or set-screw type with steel housing for EMT conduits
 2. Screw-in type for flexible metal conduit
 3. Seal-Tite type for liquid-tight flexible metal conduit
 4. PVC Conduit
 - a. PVC fittings shall be PVC type. Use PVC adapters at all boxes
 - b. Brush applied PVC Cement
 - c. All PVC components (conduit, fittings, cement) shall be from the same Manufacturer
 5. Rigid and IMC conduit fittings shall be threaded and designed for conduit use
 - C. Prohibited Materials
 1. Aluminum Conduit
 2. Crimp-on, tap-on, indenter type fittings
 3. Malleable iron or cast set-screw fittings for EMT
 4. Spray (aerosol) PVC cement
 5. Type MC or AC Cable
 6. ENT Conduit
- 2.2 WIRES AND CABLES
- A. Conductors
 1. Feeders in conduit and ducts shall be copper-type THW, THHN, or XHHW
 2. Branch circuits in conduit in dry locations shall be copper, minimum #12 AWG – Type THHN
 - B. Connectors
 1. Type 512, 3M tapeless steel spring wire connectors or pressure type terminal lugs as specified in the Contract Documents
- 2.3 BOXES
- A. Outlet Boxes
 1. Galvanized steel and correct size and shape
 2. Provide metal supports and other accessories for installation of each box
 3. Equip ceiling and bracket fixture boxes with fixture studs, where required
 4. No outlet box shall be smaller than 4 inches (100mm); for 1 inch (25mm) diameter conduit, boxes shall be 4-11/16 inch (120mm) minimum

2.4 WIRING DEVICES

A. Switches and Receptacles

1. Switches are 20 ampere. Where higher ampere devices are required they shall be of the same series as those listed. Devices of single type shall be of the same Manufacturer
2. Approved Manufacturers
 - a. Switches
 - i. Hubbell – CS1221 Series
 - ii. Approved Equal

B. Receptacles

1. Receptacles are to be 15 amperes. Where higher ampere devices are required they shall be of the same series as those listed. Devices of single type shall be of the same Manufacturer
2. Approve Manufacturers
 - a. Receptacles
 - i. Hubbell – CR5252 Series
 - ii. Approved Equal
 - b. Ground Fault Receptacles
 - i. Hubbell – GF5352I
 - ii. Leviton – 6899-I
 - iii. Pass & Seymour – 2091-S-I
 - iv. Approved Equal

C. Weatherproof Receptacles

1. Complete with corrosion resistant plate, spring lid cover, and weatherproof mats
2. Approved Manufacturers
 - a. Pass & Seymour – WP-8
 - b. Approved Equal

D. Plates

1. Metal covers shall be used for all surface-mounted boxes

2.5 SUPPORTING DEVICES AND HANGERS

A. Approved Manufacturers

1. Erico Products, Incorporated
2. Steel City
3. Minerallac
4. Approved Equal

B. Provide the appropriate supporting devices and hangers for electrical equipment from the following:

1. Beam Clamps
 - a. Set-Screw Type
 - b. Universal Clamps
 - c. Vertical Flange Clamps (Beam Clamps)
2. Clips
 - a. Conduit Clips
 - b. Combination Push-in Conduit Clips

- c. Flexible Conduit Clips
- d. Special Combination Conduit Clips
- e. "Z" Purlin Clips
- 3. Combination Conduit Hanger Clamps
- 4. One Hole Steel Strap
- 5. Minerallac Conduit Hangers
- 6. Other Hangers or Supports per the discretion of the Engineer

PART 3 - EXECUTION**3.1 RACEWAY INSTALLATION**

- A. Keep all raceway runs a minimum of 6 inches (150mm) from hot water or vent lines
- B. Conduit in concrete slabs shall not exceed 3/4 inch (20mm) I.P. size and shall be spaced no closer than 8 inches (200mm) on center except at panel and junction boxes where they are to be spread as widely as possible; special framing may be required where conduits enter a panel board
- C. Support conduit and boxes in an appropriate manner by:
 - 1. Expansion shields in concrete or solid masonry
 - 2. Toggle bolts on hollow masonry units
 - 3. Wood screws on wood
 - 4. Metal screw on metal
- D. Secure conduit with approved supports within 3 feet (1m) of every outlet box, junction box, gutter, panel, fitting, etc. Do not space supports further apart than 10 feet (3m). Do not support conduit on suspended ceiling grid (tile or sheet rock)
- E. Cap conduit ends during construction
- F. Clean or replace conduit in which water or foreign matter has accumulated
- G. Install insulated bushings on each end of conduit 1-1/4 inch (32mm) in diameter and larger
- H. Install grounding conductor in PVC conduit
- I. Bending of PVC shall be by hot box
- J. Route exposed conduit at right angles or parallel to walls of buildings and not "as the crow flies". Neatly rack parallel conduits together and make bends uniform to one another. Where installation is made inferior utilizing poor practice contrary to these methods as determined by the Engineer, said installation will be removed and reinstalled at the Contractor's expense
- K. Coat buried Rigid or IMC Conduit with approved asphaltic compound or wrap with two layers of approved corrosion protection tape
- L. Leave one (1) #10 or equivalent nylon pull wire in empty conduits
- M. When PVC conduit is used, turn up with Rigid Galvanized elbows and risers to provide equipment grounding conductor in accordance with NEC, Article 250
- N. Cut and thread conduit so ends will butt in couplings. Make threads no longer than necessary and ream pipe free of burrs
- O. Prohibited Procedures
 - 1. Use of wooden plugs inserted in concrete or masonry units as base for fastening conduits, tubing, boxes, cabinets, or other equipment
 - 2. Installation of conduit or tubing that has been crushed or deformed
 - 3. Torches for bending PVC Conduit

3.2 WIRES AND CABLES INSTALLATION

- A. Install Conductors in Raceway
- B. Pulling Conductors
 - 1. Do not pull Conductions into conduit until raceway system is complete and cabinets and outlet boxes are free of foreign matter and moisture
 - 2. Do not use heavy mechanical means for pulling conductors
 - 3. Only wire pulling lubricant may be used
- C. Conductors shall be continuous from outlet to outlet
- D. Making splices for Conductors #8 AWG and smaller with steel spring wire connections. Splice larger conductors with Lock-Tite type silicon bronze type connectors. Insulated connections of #8 AWG wire and larger with 3M #33 tape
- E. Run Conductors of different voltage systems in separate conduits
- F. Leave sufficient slack at terminations to make proper connections
- G. Conductor size #10 AWG and smaller shall be colored throughout. Color code Conductors as follows:
 - 1. 120/240 volts
 - a. Black – Phase A
 - b. Red – Phase B
 - c. Green – Ground
 - d. White – Neutral
 - 2. Approved color tape is acceptable for feeders only

3.3 BOXES INSTALLATION

- A. Boxes shall be accessible and installed with appropriate cover
- B. Sectional boxes shall not be used in concrete
- C. Locate boxes so outlets are not obstructed by pipes, ducts, or other items
- D. Label all circuits and source panels on exterior of each junction box

3.4 WIRING DEVICES INSTALLATION

- A. Provide properly sized outlet boxes for all wiring devices of types specified for outlets and junction boxes in the Contract Documents
- B. Properly wire all convenience outlets so that the hot wire, the neutral wire, and the ground wire connect to the proper terminal on all receptacles
- C. Label source panel and circuit number on the back of all device cover plates
- D. Provide grounding jumper from device grounding terminal to metal back box
- E. Provide GFI receptacles in areas as required by the NEC whether indicated on the Contract Documents or not.

3.5 SUPPORTING DEVICES AND HANGERS INSTALLATION

- A. Secure conduits to within 3 feet (1m) of each outlet box, junction box, cabinet, fitting, etc and at intervals not exceeding 10 feet (3m)
- B. Install clamps secured to structure for feeder and other conduit routed against the structure. Use drop rods and hangers to support conduits run apart from the structure

- C. Paint all supporting metal not otherwise protected, with rust inhibiting primer and then with a finish coat, if appropriate to match the surrounding metal surfaces
- D. Use of chains, perforated iron, baling wire, rope, or tie wire for supporting conduit runs will not be permitted

END OF SECTION

SECTION 13 1611 – WATER FEATURE GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Furnish and install for entire electrical installation as specified below and described in the Contract Documents:
 - a. Separately Derived Systems
 - b. Conduits and other conductor enclosures
 - c. Neutral or identified conductor of interior wiring system
 - d. Panel Boards and Control Panels
 - e. Non-current-carrying metal parts of fixed equipment such as motors, starters and controller cabinets, light fixtures, and other metal water feature accessories
- B. Related Sections:
 - 1. SECTION 13 1202 – WATER FEATURE STEEL REINFORCEMENT
 - 2. SECTION 13 1305 – WATER FEATURE ACCESSORIES
 - 3. SECTION 13 1502 – WATER FEATURE PUMPS AND MOTORS
 - 4. SECTION 13 1504 – WATER FEATURE CHEMICAL FEED SYSTEMS
 - 5. SECTION 13 1505 – WATER FEATURE OZONE GENERATION AND INJECTION
 - 6. SECTION 13 1506 – WATER FEATURE UV STERILIZERS
 - 7. SECTION 13 1507 – WATER FEATURE HEATERS
 - 8. SECTION 13 1508 – WATER FEATURE HYDRONIC SYSTEMS
 - 9. SECTION 13 1509 – WATER FEATURE CHILLERS
 - 10. SECTION 13 1510 – WATER FEATURE HEAT EXCHANGERS
 - 11. SECTION 13 1511 – WATER FEATURE VALVES, GAUGES, AND METERS
 - 12. SECTION 13 1602 – WATER FEATURE CONTROLS
 - 13. SECTION 13 1605 – WATER FEATURE CONTROL PANELS
 - 14. SECTION 13 1607 – WATER FEATURE PROGRAMMABLE LOGIC CONTROLLERS
 - 15. SECTION 13 1609 – WATER FEATURE MOTOR DISCONNECTS AND STARTERS
 - 16. SECTION 13 1610 – WATER FEATURE ELECTRICAL ACCESSORIES
 - 17. SECTION 26 0000 – ELECTRICAL
- C. References:
 - 1. NFPA 70 – National Electrical Code (NEC) – Article 250 Grounding
 - 2. Underwriters Laboratories (UL)

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Size materials as shown on the Contract Documents and in accordance with all applicable codes
- B. Grounding Conductors shall be bare copper or copper with green insulation
- C. Make grounding conductor connections to grounding electrodes and water pipes using approved bolted clamps of bronze or brass designed for such use
- D. Concrete encases grounding electrode (UFER Ground): # 2/0 AWG bare copper conductor
- E. Insulated grounding bushings: Plated malleable iron body with 150 °C molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners
- F. Grounding Rods: Steel with copper welded exterior 3/4 inch (20mm) diameter by 10 inches (250mm) long

- G. Connections to structural steel, grounding rods, or splices: for splicing and/or connecting conductors, use exothermic welds or high pressure compression type connectors. Provide exothermic weld kits manufactured by Cadweld

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Pull ground conductors in all non-metallic raceways, flexible conduit, and liquid tight flexible conduit. Use same size ground as phase conductors up through #10 AWG. Using NEC Table 250-66 for all others unless otherwise on Contract Documents
- B. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold water piping systems.
- C. Provide bonding jumpers from all wiring devices grounding terminals to metal back box.
- D. Provide grounding for water feature steel reinforcement and metal accessories and equal potential grid for water feature decks as per NEC

END OF SECTION

Section 13 18 19 – RENTAL SKATE STORAGE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions

1.2 SUMMARY

- A. This section includes shelving for the storage of rental skates as noted on the drawings with the following:
 - 1. Skate Rack Materials, Design and Quality Specifications
 - 2. Skate rack uprights
 - 3. Skate rack shelves with track system
 - 4. Skate holders

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles and finishes.
- B. Shop Drawings: Plans showing shelf layout; accessories, aisle widths and attachment to other work

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: (if included) An experienced installer who has specialized in installing work similar in material, design and extent to that indicated for this project and who is acceptable to the manufacturer
- B. Source Limitations: Obtain each type of uprights, shelving and skate holders required, including accessories and mounting components through one source from a single manufacturer.

1.5 WARRANTY

- A. Manufacturer's Warranty: Submit manufacturer's standard warranty
 - 1. Warranty Period: One year from date of Substantial Completion

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install skate racks until space is enclosed and weatherproof; wet work in space is dry; finishes, including painting are complete; and work above ceilings is complete. Do not install skate racks until ambient temperatures and humidity conditions are continuously maintained at levels anticipated for final occupancy.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Becker Arena Products, Inc. Shakopee, MN (800-234-5522)

2.2 MATERIALS AND FINISHES

- A. Skate Rack Uprights: The powder coated steel skate rack uprights shall be fabricated as to allow for either single sided or double-sided shelving. Wall mount brackets to be included if shelves are mounted against walls. Each upright shall have a 1/4"x 6" x 6" plate (Single sided shelves) or 1/4" x 6" x 9" plate (double sided shelves) welded to the bottom so that each upright can be anchored to the concrete floor. Two 1/4" gusset plates will be added for additional support for systems not anchored to a wall. Each 6" x 6" plate to have three or four (Depending on post location) 5/8" diameter holes punched into it so that the plate can be anchored and adjusted to the floor.
- B. Upright posts to be installed either 36" or 48" on center depending on the shelf configuration required.
- C. 1/2" LDT concrete anchors (three per post) to anchor each upright post.
- D. Shelving: 36" and 48" wide powder coated steel shelves shall be install (Six per section) with adjustment track factory installed to shelves.
- E. Shelving Depth: Standard shelf depths – 10" shelf for single deep skate storage (9.5" skate holders)
24" shelf for double deep skate storage (23.5" skate holders)
- F. PVC Adjustment Track: Each standard 10" shelf shall have two adjustment tracks attach to allow for adjustment of the skate holders to accommodate different size skates. Each 24" deep shelf shall have three adjustment tracks attached. The adjustment tracks shall be attached to the shelving using aluminum rivets.

- G. PVC Skate Holders: Skate holders to be installed on the adjustment track after the skate rack uprights and shelves are installed. (Final positioning of skate holders by owner, based on skate sizes) Each shelf to be supplied with the following number of skate holders: 36" shelves – 4 pair (8 holders) 48" shelves 5 pair (10 holders). Each skate holder to be furnished with two square nuts and two bolts for the attachment to the adjustment tracks.
- H. Skate rack uprights and shelves to be furnished in a beige colored powder coat painted finish. All fasteners to be supplied with zinc plated finish. Plastic adjustment track and skate holders to be furnished in a beige color to match shelving and uprights.

PART 3 - EXECUTION

3.1 - INSTALLATION

- A. Manufacturer will construct, fabricate and deliver all materials to job site per plans and specifications. All materials will be installed to be straight and true to line and properly braced.
- B. The materials shall be delivered to the job site in an enclosed trailer for protection from road grime.
- C. The contractor shall be responsible for all area clean up of construction debris.

END OF SECTION 13 18 19

SECTION 220100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

- A. General Conditions and Division 01 apply to this Division.

1.2 SCOPE

- A. Includes -
 - 1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
 - 2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
 - 3. Furnish exact location of electrical connections and information on motor controls to Division 26.
 - 4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
 - 5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
 - 6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
 - 7. Air balance, final adjustment and test run.
 - 8. The satisfactory performance of the completed systems is a requirement of this specification.
- B. Related Work Specified Elsewhere
 - 1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 26.
 - 2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 26.

1.3 SITE OBSERVATION

- A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.
- B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

- A. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc; however, locations are to be regarded as shown diagrammatically only. Follow as closely as actual building construction and work of other trades will permit.
- B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate existing structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with local and state agencies having jurisdiction and any changes required by them shall be brought to the attention of the Engineer prior to bidding or commencement of work. It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for the installation of systems according to the true intent and meaning of the Contract Documents. Anything not clear or in conflict will be explained by making application to the Engineer in writing. Should conditions arise where certain changes would be advisable, secure Owner's and Engineer approval for these changes before proceeding with work.

1.5 COORDINATION OF WORK:

- A. Coordinate work of various trades in installing interrelated work. Before installation of mechanical items, make proper provision to avoid interferences in a manner approved by Engineer. Changes required in work specified in Division 22 and 23 caused by neglect to secure approval shall be made at no cost to Owner.
- B. Arrange piping, ductwork, and equipment to permit ready access to valves, unions, starters, motors, control components, and to clear openings of doors and access panels. Contractor shall provide all necessary access doors and/or panels to provide complete access to all mechanical equipment, dampers, or accessories. Doors for dampers, etc. shall be minimum 12" x 12" and doors for mechanical equipment shall be minimum 24" x 24".
- C. Furnish and install inserts and supports required by Division 22 and 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions involved in sufficient time to be built into the construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Contractor.
- D. Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Owner and Architect. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.

1. Patch and repair walls, floors and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
 2. This Division shall bear expense of cutting, patching, repairing, and replacing of work of other Divisions because of its fault, error, tardiness, or because of damage done by it.
 3. Provide the necessary cutting, patching, repairing, and replacing pavements, sidewalks, etc. to permit installation of work of this Division.
- E. Adjust locations of piping, ductwork, equipment, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and cut prior to fabrication.
1. Make offsets, transitions, and changes in direction of piping, ductwork, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.
- F. Slots and openings through floors, walls and roofs shall be provided by this Division.
- G. This Contractor shall schedule his work, store his equipment and materials, and work in harmony with other Contractors so as to not delay or jeopardize the construction.
- H. This Division shall coordinate with electrical contractor to insure that all required components of control work are included and fully understood. Any discrepancies shall be called to the attention of the Engineer before completion of bids. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.6 EQUIPMENT & MATERIALS:

- A. Requests for substitution shall be received in writing a minimum of seven days prior to bidding. Prior acceptance shall be by Manufacturer's name only. Items not listed in this specification or subsequent addendums shall not be considered. No oral approvals will be acceptable. Manufacturers listed in this specification are acceptable only for items listed. All other items manufacturer wishes to bid must be prior approved. All equipment shall be subject to final review in accordance with "Project Submittals".
- B. Product Approvals -
1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
 2. In the event other than specified equipment is used and will not fit job site conditions, this Division assumes responsibility for replacement with items named in Specification.
- C. Use domestic made pipe, pipe fittings, and motors on Project.

- D. Motor and equipment name plates as well as applicable UL labels shall be in place when Project is turned over to Owner.
- E. Insure that items to be furnished fit spaces available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. Do not scale off drawings.
- F. All materials shall be of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended. Materials shall be new unless specifically excepted.
- G. Equipment catalog or model numbers shown define the basic equipment types and quality standard only. Catalog numbers shall not be considered as all inclusive and shall be verified to include all devices, controls, operators, and appurtenances necessary for the satisfactory and complete operation of the equipment.
- H. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.
 - 1. Promptly notify Engineer in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain Engineer's written instructions before proceeding with work. Contractor shall bear all expenses arising from correcting deficiencies of work that does not comply with Manufacturer's directions or such written instructions.
- I. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

1.7 PROJECT SUBMITTALS:

- A. Furnish complete catalog data for manufactured items of equipment to be used in the Work to for review within 15 days after award of Contract.
- B. Submittal shall include, but not be limited to the following:
 - 1. equipment scheduled
 - 2. balancing contractor
 - 3. insulation
 - 4. grilles, and diffusers
 - 5. automatic temperature controls
 - 6. certificates of guarantee
 - 7. valves
 - 8. plumbing fixtures, accessories, and specialties
 - 9. any item for which more than one manufacturer is mentioned
- C. Submit a minimum of five copies of data in binders and index in same order and name as they appear in Specification. - Optional: Provide electronic submittals. Electronic

submittals shall be in .pdf format, and shall be compiled into a single file, with bookmarks for each piece of equipment.

1. State sizes, capacities, brand names, motor HP, electrical requirements, accessories, materials, gauges, dimensions, and other pertinent information.
 2. List on catalog covers page numbers of submitted items.
 3. Underline or highlight applicable data.
- D. If material or equipment is not as specified or submittal is not complete, it will be rejected.
- E. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.
- F. Review comments shall not relieve this Division from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.
- G. Check work described by catalog data with Contract Documents for deviations and errors.
- H. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations and drawing layouts.
- I. The Contractor shall review the submittals prior to submission to make sure that the submittals are complete in all details. No submittal will be reviewed which does not bear the contractor's notation that such checking has been made.
- J. No partial submittals will be considered unless approved by the Engineer.
- K. Manufacturers' names shall be mentioned as acceptable prior to bidding.
- L. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.
- M. Contractor shall review equipment submittals for compliance with schedules, specifications, and drawing plans and details. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.
- N. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment. Submittals shall clearly indicate name of manufacturer of each item.
- O. For unacceptable items, the right shall be reserved to require the first named specified items.

- P. Where submittals are sent with any of the above listed information missing or are incomplete they will be returned to the contractor unchecked to be completed and resubmitted. No additional time or money shall be allowed for failure to provide complete submittals on the first review.
- Q. If an item requiring submittal review is ordered, purchased, shipped, or installed prior to the submittal review the item shall be removed from the job site and replaced with an approved item at contractors expense.

1.8 CLEANING & FINISHING:

- A. Contractor shall, at all times, keep the premises free from waste material and rubbish. Upon completion of this Section of the work, Contractor shall remove all surplus materials and rubbish; clean all spots resulting from the mechanical work from hardware, floors, glass, walls, etc.; do all required patching up and repair all work of other trades damaged by Contractor under this Section of the work, and leave the premises in a clean orderly condition. Clean heating and cooling coils, internally and externally, and replace all air filters prior to final mechanical inspection. Remove rust, plaster, dirt, grease and oil before painting, insulating, or exposing to view the equipment, piping, ductwork, etc. in completed structure. Refinish any damaged surfaces and leave in proper working order at final completion.

1.9 EQUIPMENT SERVICING:

- A. Prior to starting mechanical equipment, all motors, bearings and moving parts shall be properly oiled, greased and lubricated as required. Full and adequate maintenance service shall be given and upon completion all equipment shall be cleaned and checked and placed in perfect condition for the Owner.
- B. Amount and type of lubricant shall be per manufacturer's specification.

1.10 SUPERVISION:

- A. The Contractor shall supervise and direct the work with his best skill and attention. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will be responsible to see that the finished work complies accurately with the Contract Documents.

1.11 SAFETY REGULATIONS:

- A. Contractor shall provide equipment, supervision, construction, procedures, and everything necessary to assure safety of life or property.
- B. Refer also to General Condition and Special Conditions for protection clauses.

1.12 LEAK DAMAGE:

- A. Contractor shall be responsible for damages to the work of other Contractors or to the building, or to its contents, people, etc., caused by leaks in any of the equipment or piping installed by him through equipment or material failures, leaking joints or disconnected pipes, fittings, or by overflows and shall make at his own expense all repairs to fixtures, building interior, contents, paint, rugs, furniture, ceiling tile, and equipment so damaged.

1.13 TOOLS AND STORAGE OF EQUIPMENT:

- A. The Contractor shall furnish all necessary tools, staging and whatever may be necessary for the installation of this work and shall at all times protect this work and others, and the materials to be used therein from damage by the weather, accident and other causes, and shall repair and make good any damage thus occurring.

1.14 WORKMANSHIP:

- A. Workmanship shall be the best quality of its kind for respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner and Engineer. Nothing contained herein shall relieve the Contractor from performing good work, perfect in all details of construction.

1.15 TEMPORARY FACILITIES:

- A. Furnishing of temporary water, space heating, sanitary facilities, drainage lines, light and power will be as specified in Division 01 General Conditions. Contractor shall arrange to bring facilities to required location of premises. All expenses involved shall be paid by the Contractor as described in General and Special Conditions.

1.16 PAINTING BY CONTRACTOR:

- A. See section 09900 for painting requirements. See also section 22 and 23 for color code requirements.
- B. Painting shall be by persons experienced in painting.
- C. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted as follows:
 - 1. The prime coat on equipment shall be factory applied. The finish coats shall be applied under Section 09900 of these specifications.
 - 2. All equipment which is to be furnished in finished painted condition by Contractor shall be left without mark, scratch or impairment to finish upon completion and acceptance of job. Any necessary refinishing to match original shall be done by Contractor. Do not paint over name plates, serial numbers or other identifying marks.
 - 3. All new piping shall be painted as required in Section 22 and 23. Paint colors shall conform to color code requirements as specified "Identification of Piping and Equipment".

1.17 EQUIPMENT BASES:

- A. Provide reinforced concrete bases under boilers, chillers, pumps, air handling units, and other equipment as necessary or as indicated on the drawings. Coordinate work with Division 03.
- B. Bases shall be 6" high, above the finish floor. The base shall extend beyond the equipment 6" in all directions, where possible. Inserts and vibration isolation systems shall be provided and installed by the Mechanical Contractor at the time the concrete is poured to accommodate and anchor the equipment used. Coordinate with vibration isolation manufacturer's requirements and Section 22 and 23. Provide a one inch beveled edge all around.

1.18 BELT GUARDS:

- A. Shall be provided, properly enclosing each belt drive system. Guards shall be easily removable, constructed of expanded metal with suitable frames corresponding with SMACNA standard and with tachometer openings. Coordinate with equipment suppliers to avoid duplication of belt guards supplied with equipment. Guards shall comply with OSHA Regulations.

1.19 ELECTRICAL WORK:

- A. Power wiring to all electrically driven apparatus shall be done under the electrical contract. See Electrical Specifications.

- B. Unless specifically noted otherwise on documents, Electrical Contractor shall furnish and install all magnetic starters including properly sized heaters, and disconnect switches as indicated on drawings or required by code.
- C. The Contractor shall verify the proper operation of equipment furnished by him. Costs for repair, replacing, re-wiring and retesting shall be borne by the Contractor without additional costs to the Owner.
- D. Motors shall be as specified.

1.20 CONTRACTOR'S USE OF BUILDING EQUIPMENT:

- A. The Contractor may use equipment such as electric motors, fans, filters, etc. when permanently installed as part of the project and with the written permission of the Owner. As each piece of equipment is used, maintenance procedures approved by the manufacturer shall be followed, a careful record shall be kept of the time used, maintenance procedure following and of any difficulty experienced with equipment. The Contractor's records on the equipment shall be submitted to the Owner upon acceptance of project. All fan belts and filter media shall be new at the beginning of the Mechanical System Operating Test Run and System Balancing. Wearing surfaces (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

1.21 INSPECTION NOTICE:

- A. The following is a basic list of guideline items so that the Architect, district building inspector/Owner's representative can be at job site for these inspections as the building progresses. Mechanical Contractor shall inform these people one week in advance of test time.
 - 1. Water tests on all sewer, waste, and rainwater piping prior to piping being concealed.
 - 2. Pressure tests on all water service piping.
 - 3. Pressure tests on hot, chilled, and condenser water supply and return piping.
 - 4. All duct work prior to installation of finished ceilings, including ductwork pressure testing.
 - 5. The initial start-up of mechanical equipment, etc.
 - 6. Any changes or problems occurring at job site.
 - 7. Inspect all vent flashings on roof prior to roofing.
 - 8. Periodic inspection at their discretion will be made to insure compliance to Contract Documents and codes. Contractor shall provide ladders, access and other assistance as requested during inspections.
 - 9. Control piping pressure tests.
 - 10. Final inspection before giving approval for final payment.

1.22 EXCAVATION AND BACKFILLING:

- A. Trench for the underground gas pipe line shall be excavated to the required depth. Rocks, trash, or other debris will not be allowed in trench or backfill and shall be removed before pipe is laid in place. After piping has been tested, inspected and approved, piping shall be backfilled. All landscaping, concrete, etc., damaged by this Contractor shall be replaced by him to the satisfaction of Owner's Representative.

1.23 WARRANTY GUARANTEE:

- A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.
- B. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.
- C. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)
- D. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.24 COMPLETION SCHEDULE:

- A. Start-up and verification of basic equipment items shall be done prior to the date of substantial completion with sufficient time to allow balancing and adjusting to be performed.
- B. At the time of the final inspection a date shall be agreed upon for completion of any remaining items. At least double the estimated cost of the work will be withheld from the Contractor's payment.

1.25 CODE REQUIREMENTS, FEES, AND PERMITS

- A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.
 - 1. American Boiler and Affiliated Industries (AB and AI)

2. American Gas Association (AGA)
3. Air Movement and Control Association (AMCA)
4. American National Standards Institute (ANSI)
5. Air Conditioning & Refrigeration Institute (ARI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2016
7. American Society of Mechanical Engineers (ASME)
8. American Society of Testing Materials (ASTM)
9. American Standards Association (ASA)
10. American Water Works Association (AWWA)
11. American Welding Society (AWS)
12. Associated Air Balance Council (AABC)
13. Heat Exchange Institute (HEI)
14. Hydraulic Institute (HI)
15. BR
16. National Electrical Code (NEC)
17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
20. International Building Code (IBC) 2018 Ed
21. International Mechanical Code (IMC) 2018 Ed
22. International Plumbing Code (IPC) with Utah Amendments 2018 Ed
23. International Energy Conservation Code (IECC) 2018 Ed
24. Utah State Safety Orders (OSHA/UOSH)
25. Utah Fire Rating Bureau
26. Utah Boiler and Pressure Vessel Law
27. Utah Air Conservation Regulations/Waste Disposal regulations.
28. ASHRAE Ventilation STD.62-2016

- B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. If conflicts do exist among the drawings, specifications and codes, the same shall be brought to the attention of the Engineer in writing prior to bidding, otherwise Contractor shall comply with applicable codes.
- C. The latest edition of all codes shall be used.
- D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.26 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

- A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Engineer, installation, operation and maintenance manuals with instructions for all new materials and equipment used in the building. The contractor shall provide three (2) hard copies of the manuals, and two (2) electronic copies of the manuals on CD or USB drive. Electronic information shall be .PDF

format. The CD's shall include the same information as the hard copies, and shall be organized in the same manner with a table of contents and electronic bookmarks for each section. CD or USB drive itself shall be labeled the same as the hard copies of the manuals. Manuals may be assembled by the Div 22 or 23 contractor, by the TAB contractor, or by a third party such as Wasatch Manuals at Office: (801) 849-0442, Cell: (801) 674-9926, or Email: wasatchmanuals@gmail.com.

- B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed three ring binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE
MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
(Date of Project Award)
(Name of Architect)

- C. Introduction

1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect, Consulting Engineers, Mechanical Contractor, and General Contractor.
3. Third page shall include a Table of Contents for the entire manual.

- D. First Section - Summary information including:

1. First page shall contain the contractor's warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.
3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

- E. Second Section - Mechanical Equipment O&M data including:

1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:
 - a. Equipment descriptions

- b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
- c. Equipment drawings, performance curves, operating characteristics, etc.
- d. Name addresses and phone number of manufacturer, fabricator and local vender clearly printed or stamped on cover.
- e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
- f. Certified drawings, where applicable, showing assembly of parts and general dimensions.

3. Approved Mechanical submittals

F. Third Section - Plumbing Equipment O&M data including:

- 1. Section shall contain general product catalog cuts, as well as exploded view drawings with parts lists for all valves and other items with multiple parts.
- 2. Approved Plumbing submittals

G. Fourth Section - Controls O&M data including:

- 1. Sequence of Operation
- 2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
- 3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system, pumps, etc. Each control diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

H. The Fifth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:

- 1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
- 2. Data sheets showing amount of air and water at each setting. See sections 230593.
- 3. List of equipment with date of last calibration.

- I. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.
- J. See the following checklist for assistance in assembling manual:

Item #	Description	Y, N, or NA
1.	3 ring heavy duty binder with Project name, number and date on cover and project name on spine.	
2.	O&M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.	
3.	Title Page [including project name, number, address, date awarded, date of substantial completion]	
4.	Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general contractor (if applicable)]	
5.	Table of Contents	
6.	Section 1 - Summary	
A.	Warranty	
B.	Mechanical's Sub-contractor List	
C.	Vendor List	
D.	Equipment List	
7.	Section 2 – Mechanical Equipment	
A.	Maintenance Schedule (including lubrication list)	
B.	Mechanical Equipment O&M Data (for each piece of equipment submitted) per specifications	
C.	Approved mechanical submittals	
8.	Section 3 – Plumbing Equipment	
A.	Plumbing equipment O&M data	
B.	Approved plumbing submittals	
9.	Section 4 - Controls	
A.	Sequence of Operation	
B.	Controls diagrams	
C.	Controls Equipment	
10.	Section 5 – Test and Balance Report	
A.	Complete Test and Balance Report per specifications	

1.27 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.
- B. Minimum instruction periods shall be as follows -
 - 1. Mechanical - Two hours.
 - 2. Plumbing - Two hours.
 - 3. Temperature Control - Two hours.
- C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.
- D. None of these instructional periods shall overlap each other.
- E. An additional four hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.28 RECORD DRAWINGS

- A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Engineer. Record drawings must be completed and submitted prior to final site observation

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION 220100

SECTION 220500 – BASIC PLUMBING AND HVAC MATERIALS AND METHODS

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. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Mechanical demolition.
 - 7. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Mechanical sleeve seals.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Available Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
 - h. Prior Approved Equal.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - e. Linkseal.
 - f. Prior Approved Equal.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- E. PVC Pipe: ASTM D 1785, Schedule 40.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

- A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- C. Coordinate with controls contractor prior to removal of any control devices.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 and 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Drawings do not show every offset, or bend that may be required. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors where indicated on drawings and where penetrating will be visible to public.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-

iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 and 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, 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.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

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. 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 requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. 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.
- 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.
 - 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 220513

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab inc.

- b. Miljoco Corporation.
 - c. Palmer Wahl Instrumentation Group.
 - d. Tel-Tru Manufacturing Company.
 - e. Trerice, H. O. Co.
 - f. Weiss Instruments, Inc.
 - g. Weksler Glass Thermometer Corp.
 - h. Winters Instruments - U.S.
- 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: plastic.
 - 8. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

- 1. Standard: ASME B40.200.
- 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- 3. Material for Use with Copper Tubing: CNR.
- 4. Material for Use with Steel Piping: CRES.
- 5. Type: Stepped shank unless straight or tapered shank is indicated.
- 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
- 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
- 8. Bore: Diameter required to match thermometer bulb or stem.
- 9. Insertion Length: Length required to match thermometer bulb or stem.
- 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
- 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab inc.
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Trerice, H. O. Co.
 - l. Watts; a Watts Water Technologies company.
 - m. Weiss Instruments, Inc.
 - n. Weksler Glass Thermometer Corp.
 - o. WIKA Instrument Corporation.
 - p. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: plastic.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
 2. Miljoco Corporation.
 3. Peterson Equipment Co., Inc.
 4. Sisco Manufacturing Company, Inc.
 5. Trerice, H. O. Co.
 6. Watts; a Watts Water Technologies company.
 7. Weiss Instruments, Inc.
 8. Weksler Glass Thermometer Corp.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install test plugs in piping tees.

- K. Install thermometers in the following locations:
 - 1. Inlet and outlet of each temperature changing piece of equipment
- L. Install pressure gages in the following locations:
 - 1. Inlet and outlet of each device or piece of equipment with a pressure drop

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 220519

SECTION 220523 – GENERAL- DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Bronze ball valves.
 - 2. Ferrous-alloy ball valves.
 - 3. Ferrous-alloy butterfly valves.
 - 4. Bronze check valves.
 - 5. Ferrous-alloy wafer check valves.
- B. Related Sections include the following:
 - 1. Division 22 and 23 Section "Mechanical Identification" for valve tags and charts.
 - 2. Division 22 and 23 Section "HVAC Instrumentation and Controls" for control valves and actuators.
 - 3. Division 22 and 23 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. NRS: Nonrising stem.
 - 4. OS&Y: Outside screw and yoke.
 - 5. PTFE: Polytetrafluoroethylene plastic.
 - 6. SWP: Steam working pressure.
 - 7. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and

its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
 - 1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- C. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- D. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- G. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 - 2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
 - 3. Handwheel: For valves other than quarter-turn types.
 - 4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
 - 5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
- H. Valves in Insulated Piping: Valves shall have 2-inch stem extensions and the following features:
 - 1. Gate Valves: Shall be rising-stem type.
 - 2. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.
 - a. Manufactures: NIBCO Nib-seal handle extension or a comparable product by one of the following:
 - 1) Conbraco Industries, Inc.; Apollo Div.
 - 2) American.
 - 3) Crane.
 - 4) Grinnel.
 - 5) Kitz.
 - 6) Watts.
 - 7) Prior approved equal.
 - 3. Butterfly Valves: Shall have extended necks.
- I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

- J. Valve Grooved Ends: AWWA C606.
- K. Solder Joint: With sockets according to ASME B16.18.
 - 1. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
- L. Threaded: With threads according to ASME B1.20.1.
- M. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE BALL VALVES

- A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: Chrome-plated bronze ball and bronze stem and; reinforced TFE seats; threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, solder or threaded ends; and 150 psig SWP 600-psigCWP rating.
 - 1. Manufacturers: NIBCO Model S-585-70 or T-585-70, or a comparable product by one of the following:
 - a. NIBCO Model S-585-70 or T-585-70
 - b. American Valve, Inc.
 - c. Conbraco Industries, Inc.; Apollo Div.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Grinnell Corporation.
 - g. Kitz Corporation of America.
 - h. NIBCO INC.
 - i. Watts Industries, Inc.; Water Products Div.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.
 - 1. Manufacturers: NIBCO Model S-585-70-66 or T-585-70-66, or a comparable product by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. American Valve, Inc.
 - c. Conbraco Industries, Inc.; Apollo Div.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Grinnell Corporation.
 - g. Kitz Corporation of America.

- h. NIBCO INC.
- i. Watts Industries, Inc.; Water Products Div.

2.4 FERROUS-ALLOY BALL VALVES

- A. Ferrous-Alloy Ball Valves, General: MSS SP-72, with ASTM A-216 Type WCB, carbon-steel body; ASTM A-351, Type CF8M vented stainless-steel ball; and ASTM A-276, Type 316 stainless-steel stem; fire rated according to API 607 (4th edition); and having flanged ends and blowout-proof stem.
- B. Class 150, Full-Port, Ferrous-Alloy Ball Valves: Split-body construction, carbon-filled TFE seats; 285 psig CWP rating.
 - 1. Manufacturers:
 - a. NIBCO Model F-515-CS-F-66-FS.
 - b. American Valve, Inc.
 - c. Conbraco Industries, Inc.; Apollo Div.
 - d. Cooper Cameron Corp.; Cooper Cameron Valves Div.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Foster Valve Co.
 - g. Hammond Valve.
 - h. Jomar International, LTD.
 - i. Kitz Corporation of America.
 - j. Milwaukee Valve Company.
 - k. Watts.

2.5 FERROUS-ALLOY BUTTERFLY VALVES

- A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:
 - 1. Full lug, grooved and flanged valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange. Valves NPS 12 and smaller shall not have exposed stem to disc fasteners and no exterior mounted fasteners to hold the liner.
 - 2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.
- B. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed EPDM seat (liner) attached to the body.
 - 1. Manufacturers: NIBCO Model LD-1000-5, or a comparable product by one of the following:

- a. Bray International, Inc.
- b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
- c. Crane Co.; Crane Valve Group; Center Line.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Div.
- f. Dover Corp.; Dover Resources Company; Norriseal Div.
- g. General Signal; DeZurik Unit.
- h. Grinnell Corporation.
- i. Hammond Valve.
- j. Kitz Corporation of America.
- k. Legend Valve & Fitting, Inc.
- l. Metraflex Co.
- m. Milwaukee Valve Company.
- n. Mueller Steam Specialty.
- o. Process Development & Control.
- p. Red-White Valve Corp.
- q. Techno Corp.
- r. Tyco International, Ltd.; Tyco Valves & Controls.
- s. Watts Industries, Inc.; Water Products Div.

C. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, BUNA Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed BUNA seat (liner) attached to the body.

1. Manufacturers: NIBCO Model LD-1100-5, or a comparable product by one of the following:

- a. Bray International, Inc.
- b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
- c. Crane Co.; Crane Valve Group; Center Line.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Div.
- f. Dover Corp.; Dover Resources Company; Norriseal Div.
- g. General Signal; DeZurik Unit.
- h. Grinnell Corporation.
- i. Hammond Valve.
- j. Kitz Corporation of America.
- k. Legend Valve & Fitting, Inc.
- l. Metraflex Co.
- m. Milwaukee Valve Company.
- n. Mueller Steam Specialty.
- o. Process Development & Control.
- p. Red-White Valve Corp.
- q. Techno Corp.
- r. Tyco International, Ltd.; Tyco Valves & Controls.
- s. Watts Industries, Inc.; Water Products Div.

D. Single-Flange, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one-piece Type 416 stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach

stem, to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. Manufacturers: NIBCO Model LD-2000-3/5, or a comparable product by one of the following:

- a. Bray International, Inc.
- b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
- c. Crane Co.; Crane Valve Group; Center Line.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Div.
- f. Dover Corp.; Dover Resources Company; Norriseal Div.
- g. General Signal; DeZurik Unit.
- h. Grinnell Corporation.
- i. Hammond Valve.
- j. Kitz Corporation of America.
- k. Legend Valve & Fitting, Inc.
- l. Metraflex Co.
- m. Milwaukee Valve Company.
- n. Mueller Steam Specialty.
- o. Process Development & Control.
- p. Red-White Valve Corp.
- q. Techno Corp.
- r. Tyco International, Ltd.; Tyco Valves & Controls.
- s. Watts Industries, Inc.; Water Products Div.

- E. Single-Flange, 200-psig CWP Rating, Aluminum-Bronze Disc, BUNA Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one-piece Type 416 stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in BUNA seat (liner).

1. Manufacturers: NIBCO Model LD-2100-3/5, or a comparable product by one of the following:

- a. Bray International, Inc.
- b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
- c. Crane Co.; Crane Valve Group; Center Line.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Div.
- f. Dover Corp.; Dover Resources Company; Norriseal Div.
- g. General Signal; DeZurik Unit.
- h. Grinnell Corporation.
- i. Hammond Valve.
- j. Kitz Corporation of America.
- k. Legend Valve & Fitting, Inc.
- l. Metraflex Co.
- m. Milwaukee Valve Company.
- n. Mueller Steam Specialty.
- o. Process Development & Control.
- p. Red-White Valve Corp.

- q. Techno Corp.
 - r. Tyco International, Ltd.; Tyco Valves & Controls.
 - s. Watts Industries, Inc.; Water Products Div.
- F. Grooved-End, Ferrous-Alloy Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron with grooved or shouldered ends, polyamide coating inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.
- 1. Manufacturers: NIBCO Model GD-4765-3/5, or a comparable product by one of the following:
 - a. Central Sprinkler Co.; Central Grooved Piping Products.
 - b. Grinnell Corporation.
 - c. Hammond Valve.
 - d. McWane, Inc.; Kennedy Valve Div.
 - e. Milwaukee Valve Company.
 - f. Mueller Steam Specialty.
 - g. Victaulic Co. of America.
- G. Grooved-End, Ferrous-Alloy Butterfly Valves with BUNA-Encapsulated Ductile-Iron Disc: Ductile-iron with grooved or shouldered ends, polyamide coating inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.
- 1. Manufacturers: NIBCO Model GD-4775-3/5, or a comparable product by one of the following:
 - a. Central Sprinkler Co.; Central Grooved Piping Products.
 - b. Grinnell Corporation.
 - c. Hammond Valve.
 - d. McWane, Inc.; Kennedy Valve Div.
 - e. Milwaukee Valve Company.
 - f. Mueller Steam Specialty.
 - g. Victaulic Co. of America.

2.6 BRONZE CHECK VALVES

- A. Bronze Check Valves, General: MSS SP-80.
- B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.
 - 1. Manufacturers: NIBCO Model S-480-Y or T-480-Y, or a comparable product by one of the following:

- a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Red-White Valve Corp.
 - e. Walworth Co.
- C. Class 125, Bronze, Lift Check Valves with BUNA Disc: ASTM B-584 bronze body and integral seat with nonmetallic BUNA disc, soldered or threaded end connections, and having 250-psig CWP rating.
 - 1. Manufacturers: NIBCO Model S-480 or T-480, or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Powell, Wm. Co.
- D. Class 300, Bronze, Swing Check Valves with Bronze Disc: ASTM B-61 bronze body and seat with regrinding-type bronze disc, Y-pattern design, threaded end connections, and having 600 psig CWP rating.
 - 1. Manufacturers: NIBCO Model T-473-B, or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Powell, Wm. Co.
- E. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
 - 1. Manufacturers: NIBCO Model S-413-Y or T-413-Y, or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Powell, Wm. Co.
- F. Class 125, Bronze, Swing Check Valves with BUNA Disc: ASTM B-62 bronze body and seat with BUNA disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
 - 1. Manufacturers: NIBCO Model S-413-W or T-413-W, or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Powell, Wm. Co.
- G. Class 150, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.

1. Manufacturers: NIBCO Model S-433-Y or T-433-Y, or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Powell, Wm. Co.

2.7 DUAL-PLATE, IRON, WAFER OR GROOVED CHECK VALVES

- A. Dual-Plate, Iron, Wafer or Grooved Check Valves, General: ANSI B16.1, spring loaded.
- B. Dual-Plate, Iron, Wafer or Grooved Check Valves: Class 125, cast-iron, flangeless body with dual, bronze discs; stainless-steel spring and stop pin; BUNA seat; and having 200 psig CWP rating.
 1. Manufacturers: NIBCO Model W-920-W or G-920-W, or a comparable product by one of the following:
 - a. Metraflex Co.
 - b. Val-Matic Valve & Mfg. Corp.
 - c. Crane.
 - d. Grinnel.
 - e. Mueller.
 - f. Watts.

2.8 CHAINWHEEL ACTUATORS

- A. Available Manufacturers:
- B. Manufacturers:
 1. Babbitt Steam Specialty Co.
 2. Roto Hammer Industries, Inc.
 3. Prior approved equal.
- C. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Throttling Service: Angle, ball, butterfly, or globe valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc or dual-plate check valves; lever and weight swing check valves; or lever and spring swing check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Chilled-Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, bronze.
 - 2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
 - 3. Butterfly Valves, NPS 2 to NPS 12: Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ferrous alloy.
 - 4. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2 to NPS 8 300-psig CWP rating, EPDM- encapsulated ductile-iron disc.
 - 5. Dual-Plate Check Valves, NPS 2-1/2 and Larger: Wafer, iron.

D. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, bronze.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
3. Butterfly Valves, NPS 2 to NPS 12 Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ferrous alloy.
4. Lift Check Valves, NPS 2 and Smaller: Class 125 , bronze with TFE disc.

E. Heating Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
3. Butterfly Valves, NPS 2 to NPS 12 Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ferrous alloy.
4. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2 to NPS 8: 300-psig CWP rating, EPDM- encapsulated ductile-iron disc.
5. Grooved-End, Ductile-Iron Butterfly Valves, NPS 10 to NPS 12: 200-psig CWP rating, EPDM- encapsulated ductile-iron disc.
6. Dual-Plate Check Valves, NPS 2-1/2 and Larger: Wafer, iron.

F. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged soldered or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End, Copper Tubing and Steel Piping: Valve ends may be grooved. Do not use for steam or steam condensate piping.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves may be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.
- E. Install valves in position to allow full stem movement.

- F. Install chainwheel operators on valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- H. Butterfly valves shall be installed with stems horizontal.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 and 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Fiberglass pipe hangers.
 - 4. Metal framing systems.
 - 5. Fiberglass strut systems.
 - 6. Thermal-hanger shield inserts.
 - 7. Fastener systems.
 - 8. Pipe stands.
 - 9. Pipe positioning systems.
 - 10. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 13 Section "Fire-Suppression Piping" for pipe hangers for fire-suppression piping.
 - 3. Division 22 and 23 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
 - 4. Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.
 - 5. Pipe positioning systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Fiberglass strut systems. Include Product Data for components.
 - 4. Pipe stands. Include Product Data for components.
 - 5. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 1. AAA Technology & Specialties Co., Inc.
 2. Bergen-Power Pipe Supports.
 3. B-Line Systems, Inc.; a division of Cooper Industries.
 4. Carpenter & Paterson, Inc.
 5. Empire Industries, Inc.
 6. ERICO/Michigan Hanger Co.
 7. Globe Pipe Hanger Products, Inc.
 8. Grinnell Corp.
 9. GS Metals Corp.
 10. National Pipe Hanger Corporation.
 11. PHD Manufacturing, Inc.
 12. PHS Industries, Inc.
 13. Piping Technology & Products, Inc.
 14. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:

1. Carpenter & Paterson, Inc.
 2. ERICO/Michigan Hanger Co.
 3. PHS Industries, Inc.
 4. Pipe Shields, Inc.
 5. Rilco Manufacturing Company, Inc.
 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - d. MKT Fastening, LLC.
 - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. 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.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 7 Section "Roof Accessories" for curbs.
- I. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 and 23 Section "Plumbing Fixtures" for plumbing fixtures.

- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. 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.
- O. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- Q. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.

- c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for

shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Freestanding and restrained spring isolators.
 - 3. Seismic snubbers.
 - 4. Restraining braces and cables.

1.3 SCOPE

- A. Provide letter of design intent.
- B. Provide full set of seismic submittals.
- C. Provide a minimum of 2 on site observations.
- D. Provide final letter of compliance completion.

1.4 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.5 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. Basic Wind Speed: Per owner's design standards.
 - 2. Building Classification Category: As defined in the IBC.
 - 3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:

1. Site Class: As defined in the IBC.
2. Assigned Seismic Use Group or Building Category: As defined in the IBC.
 - a. Component Importance Factor: 1.0.

1.6 SUBMITTALS

- A. Product Data: For the following:
 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.
- C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.
 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 4. Seismic- and Wind-Restraint Details:

- a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing's. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- D. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- E. Welding certificates.
- F. Qualification Data: For professional engineer and testing agency.
- G. Field quality-control test reports.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Provide a minimum of 2 site observations, and additional observations if required.

- F. Upon project completion provide a final letter of acceptance for seismic restraints system and installation.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
 2. Vibro-acoustics.
 3. ISAT
 4. Mason Industries.
 5. Caddy
 6. Prior approved equal.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene or rubber.
- C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
 2. Hilti, Inc.
 3. ISAT
 4. Kinetics Noise Control.

5. Mason Industries.
 6. Vibro-acoustics.
 7. Gripple.
 8. Unistrut; Tyco International, Ltd.
 9. Prior approved equal.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.
- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.
- G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid

mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Piping Restraints:
1. Comply with requirements in MSS SP-127.
 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 3. Brace a change of direction longer than 12 feet.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.

- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment signs.
 - 3. Access panel and door markers.
 - 4. Pipe markers.
 - 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.

- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Data: Instructions for operation of equipment and for safety procedures.
 - 2. Engraving: Manufacturer's standard letter style, 1/4" or larger with terms to match equipment identification.
 - 3. Thickness: 1/8 inch, unless otherwise indicated.
 - 4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- C. Access Panel and Door Markers: 1/16" thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8" center hole for attachment.
 - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bradley.
 - b. Kolbi.
 - c. Prior approved.
 - 2. Colors: Comply with ASME A13.1, unless otherwise indicated.

3. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 22 and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
1. Fuel-burning units, including boilers, furnaces, heaters, etc.
 2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 4. Fans, blowers, primary balancing dampers, and mixing boxes.
 5. Packaged HVAC central-station and zone-type units.
- B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
1. Identify mechanical equipment with black equipment markers with white lettering.
 2. Letter Size: Minimum 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.
 3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 4. Include signs for the following general categories of equipment:

- a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fuel-burning units, including boilers, furnaces, heaters, etc.
 - c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - e. Fans, blowers, primary balancing dampers, and mixing boxes.
 - f. Packaged HVAC central-station and zone-type units.
 - g. Tanks and pressure vessels.
 - h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed 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 nonaccessible 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 markers.
- C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 220553

SECTION 220700 - HVAC AND PLUMBING INSULATION

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. Section Includes:
 - 1. Insulation Materials:
 - a. Mineral fiber.
 - 2. Insulating cements.
 - 3. Adhesives.
 - 4. Lagging adhesives.
 - 5. Factory-applied jackets.
 - 6. Field-applied jackets.
 - 7. Tapes.
 - 8. Securements.
 - 9. Corner angles.
- B. Related Sections:
 - 1. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

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. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 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 size and location of supports, hangers, and insulation shields specified in Division 22 and 23 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. 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 Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors. Provide a weather protective sheet metal jacket for outdoor installation.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.
 - f. Prior approved equal.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - f. Prior approved equal.
 - 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.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
 - c. Prior approved equal.

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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-127.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-60/ 85-70.
 - c. Marathon Industries, Inc.; 225.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - e. Prior approved equal.

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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of H.B. Fuller; CR 50 AHV2.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 - d. Prior approved equal.
 - 2. Service Temperature Range: Minus 50 to plus 180 deg F.
 - 3. Color: White.

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - e. Prior approved equal.
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, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 - e. Prior approved equal.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
8. Adhesion: 64 ounces force/inch in width.
9. Elongation: 500 percent.
10. Tensile Strength: 18 lbf/inch in width.

- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.

- c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 - e. Prior approved equal.
- 2. Width: 2 inches.
 - 3. Thickness: 3.7 mils.
 - 4. Adhesion: 100 ounces force/inch in width.
 - 5. Elongation: 5 percent.
 - 6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 - d. Prior approved equal.
- 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
- 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.
- 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.

2.8 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

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 equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by

tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.
- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory-

or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations

of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return, Air.
4. Indoor, exposed return, Air.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, concealed exhaust.
7. Indoor, exposed exhaust.

- B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round and flat-oval duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

- B. Concealed, low pressure, round rectangular, and flat-oval exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

- C. Rectangular, low pressure, supply-air duct insulation shall be lined per Section "Metal Ducts".

- D. Rectangular, return-air duct insulation shall be lined per Section "Metal Ducts".

- E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

- F. Exposed or medium pressure, round and flat-oval, supply-air, and return air duct insulation shall be a perforated linear. See Section "Metal Ducts".

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
 4. Vertical roof drain piping.
- C. Piping System insulation:
1. Hydronic Piping - Mineral Fiber, per chart.
 2. Domestic Cold Water Piping -Mineral Fiber, 1/2"
 3. Domestic Hot Water Piping -Mineral Fiber, per chart
 4. Horizontal Roof Drain Piping - Mineral Fiber, 1/2".
 5. Refrigerant Piping - Flexible elastomeric, 1".

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2016, with modifications per 2018 IECC

Fluid Operating Temperature Range and usage (F°)	Insulation Conductivity		Nominal Pipe or Tube Size (inches)				
	Conductivity Btu-in./ (h-ft ² -F°)	Mean Rating Temp. F°	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
 - 1. PVC: 20 mils thick.
- D. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2016, with modifications per 2018 IECC

3.13 DUCT INSULATION SCHEDULE

- A. Minimum Duct Insulation R-Value, Cooling and Heating Supply Ducts and Return Ducts ANSI/ASHRAE/IES Standard 90.1-2016.

Duct Location							
Climate Zone	Exterior	Ventilated Attic	Unvented Attic Above Insulated Ceiling	Unvented Attic with Roof Insulation	Unconditioned Space	Indirectly Conditioned Space	Buried
Heating- Only Ducts							
5	R-6	R-3.5	none	none	none	none	R-3.5
Cooling-Only Ducts							
5,6	R-3.5	R-1.9	R-3.5	R-1.9	R-1.9	none	none
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none
Combine Heating and Cooling							
Supply Ducts							
5	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none

3.14 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Exterior piping, Exposed:
 - 1. Aluminum jacket.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

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. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Flexible connectors.
 - 3. Escutcheons.
 - 4. Sleeves and sleeve seals.
 - 5. Wall penetration systems.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to 2012 IBC.

1.4 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Escutcheons.
 - 5. Sleeves and sleeve seals.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.
- E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
- F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.
- G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.5 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
- G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.6 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.

3. Metraflex, Inc.
 4. Pipeline Seal and Insulator, Inc.
 5. Prior approved equal.
- B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.7 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with

requirements in Division 22 and 23 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- H. Install domestic water piping level without pitch and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. Install seismic restraints on piping. Comply with requirements in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- L. 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.
- M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- N. Install piping adjacent to equipment and specialties to allow service and maintenance.
- O. Install piping to permit valve servicing.
- P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- Q. Install piping free of sags and bends.
- R. Install fittings for changes in direction and branch connections.
- S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- T. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- U. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 and 23 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping

NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.

- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
 - 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.
5. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw or spring clips.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:

1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with exposed-rivet hinge and set screw or spring clips.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with set screw or spring clips.
7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.9 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

- K. Install sleeve materials according to the following applications:
1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. PVC pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe Insert type.
 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - d. Do not use sleeves when wall penetration systems are used.
 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.

3.10 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 WALL PENETRATION SYSTEM INSTALLATION

- A. Install wall penetration systems in new, exterior concrete walls.
- B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.12 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 100 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.14 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 CLEANING

- A. Clean and disinfect potable and non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:

- 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.16 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping shall be the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

3.17 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.

4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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 domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Strainers.
 - 3. Hose bibbs.
 - 4. Drain valves.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Zurn Plumbing Products Group; Wilkins Div.
 - i. Prior approved equal.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrowhead Brass Products, Inc.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Woodford Manufacturing Company.
 - i. Zurn Plumbing Products Group; Light Commercial Operation.
 - j. Zurn Plumbing Products Group; Wilkins Div.
 - k. Prior approved equal.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Drain: Factory-installed, hose-end drain valve.

2.3 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.4 DRAIN VALVES

A. Ball-Valve-Type, Threaded-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: 1.5"
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple cap with brass chain.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 and 23 Section "Common work results" for piping joining materials, joint construction, and basic installation requirements.
- B. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER PUMPS

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 all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:
 - 1. Wet Rotor Circulators.

1.3 SUBMITTALS

- A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For domestic water pumps to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 100% LEAD-FREE WET ROTOR CIRCULATORS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett Domestic Pump; ITT Industries.
 - 3. Grundfos Pumps Corp.
 - 4. Taco, Inc.
 - 5. Prior approved equal.
- B. Description:
 - 1. In-line wet rotor circulation pumps designed specifically for quiet operation in open (potable) water systems. Pumps shall have 100% lead-free bronze or stainless steel bodies.
 - 2. Provide with Aquastat.
- C. Construction Materials:
 - 1. Pump Body:
 - a. NBF: 100% lead-free bronze.
 - b. SSF: Stainless Steel.
 - 2. Bearings: Carbon
 - 3. Impeller:
 - a. NBF-33, NBF-36, NBF-45: Noryl.
 - b. All Others: Polypropylene.
 - 4. Shaft: Ceramic
- D. Operating Data

1. Maximum Working Pressure: 150 psi (10.3 Bar)
2. Maximum Operating Temperature:
 - a. NBF-33, NBF-36, NBF-45: 225EF.
 - b. All Others: 230EF.

E. Capacities and Characteristics: See drawings.

2.3 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
1. Manufacturers:
 - a. Honeywell International, Inc.
 - b. Square D.
 - c. White-Rodgers Div.; Emerson Electric Co.
 - d. Prior approved equal.
 2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
 3. Range: 65 to 200 deg F.
 4. Operation of Pump: On or off.
 5. Transformer: Provide if required.
 6. Power Requirement: 24 V, ac or 120 V, ac.

2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

- A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
1. On-off status of each pump.
 2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONTROL INSTALLATION

- A. Install immersion-type thermostats in hot-water return piping.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 and 23 Section "Domestic Water Piping."
 - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Separately coupled, in-line centrifugal pumps.
 - b. Separately coupled, horizontally mounted, in-line centrifugal pumps.
 - c. Close-coupled, horizontally mounted, in-line centrifugal pumps.
 - d. Close-coupled, vertically mounted, in-line centrifugal pumps.
 - 2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 and 23 Section "Valves" for general-duty valves for domestic water piping and Division 22 and 23 Section "Plumbing Specialties" for strainers.
 - 3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 and 23 Section "Meters and Gages" for pressure gages and gage connectors.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."
- E. Connect wiring according to Division 26 Section "Conductors and Cables."
- F. Connect thermostats to pumps that they control.
- G. Interlock pump with water heater burner and time delay relay.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 221123

SECTION 221316- SANITARY WASTE AND VENT PIPING

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. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
- B. Related Sections:
 - 1. Division 2 Section "Sanitary Sewerage" for sanitary sewerage piping and structures outside the building.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.\
- B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.
- C. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dww" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than 72 hours in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Fernco Inc.
 - c. MIFAB, Inc.
 - d. Tyler Pipe.
 - e. Prior approved equal.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. MIFAB, Inc.
 - c. Tyler Pipe.
 - d. Prior approved equal.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
 1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Solvent Cement: ASTM D 2564.
 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 3. Unshielded, Nonpressure Transition Couplings:

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company; a division of MCP Industries, Inc.
 - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - 5) Prior approved equal.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition Couplings:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - 3) Prior approved equal.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Pressure Transition Couplings:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Dresser, Inc.
 - 3) EBAA Iron, Inc.
 - 4) JCM Industries, Inc.
 - 5) Romac Industries, Inc.
 - 6) Smith-Blair, Inc; a Sensus company.
 - 7) The Ford Meter Box Company, Inc.
 - 8) Viking Johnson.
 - 9) Prior approved equal.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends

of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- O. Install aboveground ABS piping according to ASTM D 2661.
- P. Install aboveground PVC piping according to ASTM D 2665.
- Q. Install underground ABS and PVC piping according to ASTM D 2321.
- R. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- S. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
- T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 and 23 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Plastic, Nonpressure-Piping, Solvent-Cement 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Shielded, nonpressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:

- a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
- b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

- 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

- 1. Install shutoff valve on each sewage pump discharge.
- 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
- 3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

- 1. Horizontal Piping: Horizontal backwater valves.
- 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
- 3. Install backwater valves in accessible locations.
- 4. Comply with requirements for backwater valve specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment."

- 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
- 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
- 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
- 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
- 5. Vertical Piping: MSS Type 8 or Type 42, clamps.

6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

5. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
 6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste and vent piping shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- C. Underground, soil, waste, and vent piping shall be any of the following:
 1. Extra Heavy class, cast-iron soil piping; calking materials; and calked joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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 sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Air-admittance valves.
 - 4. Trap Guards.
 - 5. Roof flashing assemblies.
 - 6. Miscellaneous sanitary drainage piping specialties.
 - 7. Flashing materials.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer, rated capacities, operating characteristics, and accessories for the following:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Air admittance valves.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Prior approved equal.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk or raised-head, cast-iron plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
 - j. Prior approved equal.
- 2. Standard: ASME A112.6.3.
 - 3. Pattern: Floor drain.
 - 4. Body Material: Gray iron.
 - 5. Clamping Device: Required.
 - 6. Outlet: Bottom.
 - 7. Top or Strainer Material: Chrome plate
 - 8. Top or Strainer Material: Stainless steel for shower drains
 - 9. Top Shape: Round.
 - 10. Top Loading Classification: Medium Duty.
 - 11. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 12. Trap Pattern: Deep-seal P-trap.
 - 13. Trap Features: Trap-seal primer valve drain connection.

2.3 AIR-ADMITTANCE VALVES

A. Wall Box:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Durgo, Inc.
 - b. Oatey.
 - c. RectorSeal.
 - d. Studor, Inc.
 - e. Prior approved equal.
- 2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
- 3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - c. Prior approved equal.

- B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - 1. Open-Top Vent Cap: Without cap.
 - 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- B. Floor-Drain, Trap-Seal Primer Fittings:
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- C. Trap Guard
 - 1. Description: Trap guard shall have flexible elastomeric material open on top, with curl closure on bottom as needed to allow water to flow, but not allow sewer gases to escape.
 - 2. Trap guards by Proset or prior approved equal.

2.6 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Applications: 12 oz./sq. ft. thickness.
 - 2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.

- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 and 23 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

- 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- G. Install air-admittance-valve wall boxes recessed in wall where indicated on drawings.
- H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- J. Install deep-seal traps on all floor drains.
- A. Install trap guards at floor drains that require trap-seal.
 - 1. Size: Same as floor drain inlet.
- B. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- C. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- D. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
 - D. Secure flashing into sleeve and specialty clamping ring or device.
 - E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."
 - F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
 - G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221413 – FACILITY STORM DRAINAGE PIPING

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 storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 30-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
 2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
- C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

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 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.

- B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) ANACO.
 - 2) Fernco, Inc.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.
 - 6) Or equal.
 - 2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) ANACO.
 - 2) Clamp-All Corp.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.
 - 6) Or equal.
 - 3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) MG Piping Products Co.
 - 2) Or equal.
- C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. ANACO.
 - 1) Or equal.

2.5 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

- C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.6 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

2.7 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco, Inc.
 - c. Logan Clay Products Company (The).
 - d. Mission Rubber Co.
 - e. NDS, Inc.
 - f. Plastic Oddities, Inc.
 - g. Or equal.
 - 2. Sleeve Materials:
 - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
 - c. Or equal.

- C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing-or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. ANACO.
 - b. Or equal.
- D. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
 - 1. Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. Or equal.
- E. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products; Star Fittings Div.
 - d. Or equal.
- F. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers:
 - a. SIGMA Corp.
 - b. Or equal.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Plastic piping shall not be allowed in ceiling return plenums. Where piping is exposed to ceiling plenums, cast iron shall be used.
- C. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; standard, and heavy-duty shielded, stainless-steel couplings; and coupled joints.
 - 3. ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 4. PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 2 Section "Storm Drainage."
- B. Basic piping installation requirements are specified in Division 22 and 23 Section "Common Work Results."
- C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
- D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Plumbing Specialties."
- E. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- F. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105.
- G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 and 23 Section "Common Work Results."
- H. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

- J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- M. Install engineered controlled-flow storm drainage piping in locations indicated.
- N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- O. Install ABS storm drainage piping according to ASTM D 2661.
- P. Install PVC storm drainage piping according to ASTM D 2665.
- Q. Install underground ABS and PVC storm drainage piping according to ASTM D 2321.
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."
- B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- D. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 and 23 Section "Valves."
- B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
 - 1. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 2. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 - 2. Install backwater valves in accessible locations.
 - 3. Backwater valve are specified in Division 22 Section "Plumbing Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 and 23 Section "Mechanical Vibration Controls and Seismic Restraints."
- B. Pipe hangers and supports are specified in Division 22 and 23 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 and 23 Section "Hangers and Supports."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6: 60 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6: 48 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.
- I. Install supports for vertical ABS and PVC piping every 48 inches.
- J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
- D. Connect force-main piping to the following:
1. Storm Sewer: To exterior force main or storm manhole.
 2. Sump Pumps: To sump pump discharge.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 20-foot head of water. From 4 hours before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

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 storm drainage piping specialties:
 - 1. Cleanouts.
 - 2. Through-penetration firestop assemblies.
 - 3. Roof drains.
 - 4. Miscellaneous storm drainage piping specialties.
 - 5. Flashing materials.
- B. Related Sections include the following:
 - 1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PUR: Polyurethane plastic.
- H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Prior approved equal.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk, cast-iron plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Metal Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
 - h. Mifab.
 - i. Prior approved equal.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Prior approved equal.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

D. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities; a division of Diverse Corporate Technologies.
 - e. Sioux Chief Manufacturing Company, Inc.

- f. Zurn Plumbing Products Group; Light Commercial Operation.
 - g. Prior approved equal.
2. Size: Same as connected branch.
 3. Body: PVC.
 4. Closure Plug: PVC.
 5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 ROOF DRAINS

A. Metal Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Marathon Roofing Products.
 - c. MIFAB, Inc.
 - d. Portals Plus, Inc.
 - e. Prier Products, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Light Commercial Operation.
 - j. Zurn Plumbing Products Group; Specification Drainage Operation.
 - k. Prior approved equal.
2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
4. Body Material: Cast iron.
5. Dimensions of Body: See drawings.
6. Combination Flashing Ring and Gravel Stop: Required.
7. Outlet: Coordinate with drawings.
8. Dome Material: Cast iron.
9. Extension Collars: Required.
10. Underdeck Clamp: Required.
11. Sump Receiver: Required.

2.3 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout.
3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
4. Size: Same as or larger than connected downspout.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

D. Downspout Nozzle:

1. All nickel bronze body with decorative face of wall flange and outlet nozzle.
2. Approved Types -
 - a. Zurn Z-199 or equal by
 - b. Wade
 - c. Smith
 - d. Josam

2.4 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7.
 - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- G. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- H. Install manufactured, gray-iron downspout boots at grade with top 18 inches above grade. Secure to building wall.
- I. Install cast-iron soil pipe downspout boots at grade with top of hub 18 inches above grade.
- J. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

SECTION 223300 - ELECTRIC WATER HEATERS

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 electric water heaters:
 - 1. Flow-control, instantaneous electric water heaters.
 - 2. Light-commercial electric water heaters.
 - 3. Compression tanks.
 - 4. Water heater accessories.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: For each type of commercial and instantaneous electric water heater, signed by product manufacturer.
- D. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:

- a. Instantaneous Electric Water Heaters: One year.
- b. Light-Commercial Electric Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Two years.
- c. Compression Tanks: One year.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSTANTANEOUS ELECTRIC WATER HEATERS

- A. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
 - 1. Manufacturers:
 - a. Chronomite Laboratories, Inc.
 - b. Controlled Energy Corporation.
 - c. Eemax, Inc.
 - d. Hot Aqua, Inc.
 - e. IMI Waterheating, Ltd.
 - f. Stiebel Eltron, Inc.
 - g. HTP
 - h. Bock
 - i. Prior approved equal.
 - 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Flow-control fitting.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 - 3. Support: Bracket for wall mounting.
 - 4. Capacity and Characteristics:
 - a. Temperature Control: Flow-control fitting.

- b. See drawings for capacity, electrical service, etc.

2.3 LIGHT-COMMERCIAL ELECTRIC WATER HEATERS

- A. Description: Comply with UL 174 for household, storage electric water heaters.

- 1. Manufacturers:

- a. American Water Heater Company.
- b. Bradford White Corporation.
- c. Electric Heater Company (The); Hubbell Heaters Division.
- d. GSW Water Heating Company.
- e. Heat Transfer Products, Inc.
- f. Lochinvar Corporation.
- g. Rheem Water Heater Div.; Rheem Manufacturing Company.
- h. Ruud Water Heater Div.; Rheem Manufacturing Company.
- i. Smith, A. O. Water Products Company.
- j. State Industries, Inc.
- k. Prior approved equal.

- 2. Storage-Tank Construction: Steel, vertical arrangement.

- a. Tappings: ASME B1.20.1 pipe thread.
- b. Pressure Rating: 150 psig.
- c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

- 3. Factory-Installed Storage-Tank Appurtenances:

- a. Anode Rod: Replaceable magnesium.
- b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
- c. Drain Valve: ASSE 1005.
- d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
- e. Jacket: Steel with enameled finish.
- f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
- g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
- h. Temperature Control: Adjustable thermostat for each element.
- i. Safety Control: High-temperature-limit cutoff device or system.
- j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

- 4. Special Requirements: NSF 5 construction with legs for off-floor installation.

- 5. Capacity and Characteristics:

- a. See drawings for size, capacity, electrical characteristics, etc.

2.4 COMPRESSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 1. Manufacturers:
 - a. AMTROL Inc.
 - b. Armstrong Pumps, Inc.
 - c. Flexcon Industries.
 - d. Honeywell Sparco.
 - e. Myers, F. E.; Pentair Pump Group (The).
 - f. Smith, A. O.; Aqua-Air Div.
 - g. State Industries, Inc.
 - h. Taco, Inc.
 - i. Watts Regulator Co.
 - j. Wessels Co.
 - k. Prior approved equal.
 - 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 3. Capacity and Characteristics: See drawings.

2.5 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.
- C. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch-high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.
- D. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

- E. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- F. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.
- G. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.
- H. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
- I. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig-maximum outlet pressure, unless otherwise indicated.
- J. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install seismic restraints for light-commercial and commercial water heaters. Anchor to substrate.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 and 23 Section "Plumbing Specialties" for hose-end drain valves.
- F. Install thermometer on outlet piping of water heaters. Refer to Division 22 and 23 Section "Meters and Gages" for thermometers.

- G. Install thermometers on inlet and outlet piping of household, collector-to-tank, solar-electric water heaters. Refer to Division 22 and 23 Section "Meters and Gages" for thermometers.
- H. Install pressure gage(s) on inlet and outlet of commercial electric water- heater piping. Refer to Division 22 and 23 Section "Meters and Gages" for pressure gages.
- I. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 and 23 Section "Valves" for general-duty valves and to Division 22 and 23 Section "Meters and Gages" for thermometers.
- J. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.
- K. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- L. Fill water heaters with water.
- M. Charge compression tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

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 conventional plumbing fixtures and related components:
 - 1. Lavatories.
 - 2. Lavatory Faucets.
 - 3. Water closets.
 - 4. Toilet seats.
 - 5. Flushometers - Water Closets.
 - 6. Urinals.
 - 7. Flushometers - Urinals.
 - 8. Fixture supports.
 - 9. Protective shielding guards.
 - 10. Commercial sinks.
 - 11. Sink Faucets.
 - 12. Service sinks.
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Operation and Maintenance Data: For plumbing fixtures to include in operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
 5. Vitreous-China Fixtures: ASME A112.19.2M.
 6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 7. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 4. Faucets: ASME A112.18.1.
 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 6. Hose-Coupling Threads: ASME B1.20.7.
 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 8. NSF Potable-Water Materials: NSF 61.
 9. Pipe Threads: ASME B1.20.1.
 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 11. Supply Fittings: ASME A112.18.1.
 12. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1.
 3. Manual-Operation Flushometers: ASSE 1037.
 4. Plastic Tubular Fittings: ASTM F 409.
 5. Brass Waste Fittings: ASME A112.18.2.
 6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
 2. Flexible Water Connectors: ASME A112.18.6.
 3. Floor Drains: ASME A112.6.3.
 4. Grab Bars: ASTM F 446.
 5. Hose-Coupling Threads: ASME B1.20.7.
 6. Hot-Water Dispensers: ASSE 1023 and UL 499.
 7. Off-Floor Fixture Supports: ASME A112.6.1M.
 8. Pipe Threads: ASME B1.20.1.
 9. Plastic Toilet Seats: ANSI Z124.5.
 10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period: One year from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 - 3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 2 of each type.
 - 4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.

PART 2 - PRODUCTS

2.1 LAVATORIES

- A. Lavatories:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Commercial Enameling Company.
 - c. Eljer.
 - d. Kohler Co.
 - e. Crane.
 - f. Sloan
 - g. Zurn.
 - 2. Description: Accessible, wall-mounting, vitreous-china fixture.

- a. Type: With back.
- b. Size: 20 by 18 inches rectangular.
- c. Faucet Hole Punching: Three holes, 4-inch centers.
- d. Color: White.
- e. Supplies: NPS 3/8 chrome-plated copper with stops.
- f. Drain: Grid with offset waste.

1) Location: Near back of bowl.

B. Lavatories, Counter Mounted:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Commercial Enameling Company.
 - b. Eljer.
 - c. Kohler Co.
 - d. American Standard.
 - e. Crane.
 - f. Sloan
 - g. Zurn.
 - h. Prior approved equal.
2. Description: Accessible Counter-mounting, vitreous-china fixture.
 - a. Type: Self-rimming.
 - b. Oval Lavatory Size: 20 by 17 inches.
 - c. Faucet Hole Punching: Three holes, 4-inch centers.
 - d. Color: White.
 - e. Supplies: NPS 3/8 chrome-plated copper with stops.
 - f. Drain: Grid with offset waste.

1) Location: Near back of bowl.

C. Mixing valve:

1. Valve shall be thermostatic and pressure mixing valve with maximum 5 degree approach temperature.
2. Approved Manufacturers -
 - a. Powers hydroguard TP or equal by
 - b. Sloan
 - c. Prior approved equal

2.2 LAVATORY FAUCETS

A. Lavatory Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Standard Companies, Inc.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Delta Faucet Company.
 - e. Eljer.
 - f. Elkay Manufacturing Co.
 - g. Fisher Manufacturing Co.
 - h. Just Manufacturing Company.
 - i. Kohler Co.
 - j. Moen, Inc.
 - k. Royal Brass Mfg. Co.
 - l. Sayco; a Briggs Plumbing Products, Inc. Company.
 - m. Speakman Company.
 - n. Sloan
 - o. T & S Brass and Bronze Works, Inc.
 - p. Zurn Plumbing Products Group; Commercial Brass Operation.
 - q. Prior approved equal.
2. Description: Sensor. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
- a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 0.5 gpm.
 - d. Centers: 4 inches.
 - e. Mounting: Deck, concealed.
 - f. Spout: Rigid type.
 - g. Spout Outlet: Aerator.
 - h. Drain: Grid.
 - i. Tempering Device: Thermostatic.

2.3 WATER CLOSETS

A. Water Closets, Floor mounted-flushvalve:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc. 3043.001 (ADA), 2234.001 (standard) or equal by
 - 1) Briggs Plumbing Products, Inc.
 - 2) Crane Plumbing, L.L.C./Fiat Products.
 - 3) Eljer.
 - 4) Kohler Co.
 - 5) TOTO USA, Inc.
 - 6) Sloan
 - 7) Zurn.

2. Description: Accessible where indicated on drawings, Floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.
 - 1) Bowl Type: Elongated front with siphon-jet design. Include bolt caps matching fixture.
 - 2) Height: Accessible where indicated on drawings.
 - 3) Design Consumption: 1.6 gal./flush.
 - 4) Color: White.

2.4 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Comfort seats C108SSCAM or equal.
 - b. American Standard Companies, Inc.
 - c. Bemis Manufacturing Company.
 - d. Church Seats.
 - e. Eljer.
 - f. Kohler Co.
 - g. Olsonite Corp.
2. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, heavy duty, solid, anti-microbial plastic.
 - b. Configuration: Open front without cover.
 - c. Hinge Type: Stainless Steel, self-sustaining.
 - d. Class: Standard commercial.
 - e. Color: White.

2.5 FLUSHOMETERS-WATER CLOSETS

A. Flushometers, Water Closets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Coyne & Delany Co.
 - b. Sloan Valve Company.
 - c. Zurn Plumbing Products Group.
 - d. Prior approved equal
2. Description: Flushometer for water closet fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

- a. Internal Design: Diaphragm operation.
- b. Style: Exposed.
- c. Inlet Size: NPS 1".
- d. Trip Mechanism: Battery-operated sensor actuator.
- e. Consumption: 1.6 gal./flush.

2.6 URINALS

A. Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Eljer.
 - d. Kohler Co.
 - e. Sloan
 - f. TOTO USA, Inc.
 - g. Zurn.
 - h. Prior approved equal.
2. Description: Accessible, where indicated on drawings, Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
 - a. Type: Blowout with extended shields.
 - b. Strainer or Trapway: Open trapway with integral trap.
 - c. Design Consumption: 1 gal./flush.
 - d. Color: White.
 - e. Supply Spud Size: NPS 3/4.
 - f. Outlet Size: NPS 1-1/2.

2.7 FLUSHOMETERS-URINALS

A. Flushometers, Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Coyne & Delany Co.
 - b. Sloan Valve Company.
 - c. Zurn Plumbing Products Group.
 - d. Prior approved equal
2. Description: Flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
 - a. Internal Design: Diaphragm operation.

- b. Style: Exposed.
- c. Inlet Size: NPS 3/4.
- d. Trip Mechanism: Battery-operated sensor actuator.
- e. Consumption: 1.0 gal./flush.

2.8 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Company.
 - 2. MIFAB Manufacturing Inc.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Tyler Pipe; Wade Div.
 - 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 7. Prior approved equal.
- B. Urinal Supports:
 - 1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.
- C. Lavatory Supports:
 - 1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.
- D. Sink Supports:
 - 1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.

2.9 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Piping Enclosures:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. TRUEBRO, Inc.
 - b. Plumberex.
 - c. McGuire.
 - d. Proflo.
 - e. Prior approved equal.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.10 COMMERCIAL SINKS

A. Commercial Sinks, Three Compartment Self Standing Sink:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkay Manufacturing Co.
 - b. Just Manufacturing Company.
 - c. Prior approved equal.
2. Description: Three-compartment, self-standing, stainless-steel commercial sink with backsplash.
 - a. Overall Dimensions: See drawings.
 - b. Metal Thickness: Minimum 18 Gauge.
 - c. Compartment:
 - 1) Drain: NPS 1-1/2 tailpiece with stopper.
 - a) Location: Centered in compartment.

2.11 SINK FAUCETS

A. Sink Faucets Three compartment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Delta Faucet Company.
 - e. Eljer.
 - f. Elkay Manufacturing Co.
 - g. Fisher Manufacturing Co.
 - h. Just Manufacturing Company.
 - i. Kohler Co.
 - j. Moen, Inc.
 - k. Sayco; a Briggs Plumbing Products, Inc. Company.
 - l. Speakman Company.
 - m. T & S Brass and Bronze Works, Inc.
 - n. Zurn Plumbing Products Group.

2. Description: Kitchen pre rinse faucet with spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
 - d. Mixing Valve: Single control.
 - e. Mounting: Deck.
 - f. Handle(s): Lever.
 - g. Spout Type: Swing, solid brass.
 - h. Spout Outlet: Aerator.

Drain: basket strainer

2.12 SERVICE SINKS

A. Service Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Commercial Enameling Company.
 - c. Eljer.
 - d. Kohler Co.
2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.
 - a. Size: 28 by 28 inches.
 - b. Color: White.
 - c. Faucet: Sink American Standard 8344.111 with threaded spout and 48 inch hose and damp or equal by
 - 1) Eljer.
 - 2) Kohler.
 - 3) Speakman.
 - d. Drain: Grid with NPS 2 outlet.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounting fixtures in and attached to casework.
- H. Install fixtures level and plumb according to roughing-in drawings.
- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 and 23 Section "Valves."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

- M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- N. Install toilet seats on water closets.
- O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- R. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- S. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."
- U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust all fixtures. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

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 water coolers and related components:
 - 1. Drinking Fountains
 - 2. Pressure water coolers.
 - 3. Fixture supports.

1.3 DEFINITIONS

- A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Cast Polymer: Dense, cast-filled-polymer plastic.
- C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
- D. Fitting: Device that controls flow of water into or out of fixture.
- E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
- F. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filter Cartridges: Equal to 100 percent of amount installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

- A. Exterior Drinking Fountains non cooled with bottle filling station, DF-1:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Elkay LK4409BFWHT or equal by:
 - b. Haws Corporation.
 - c. Most Dependable Fountains, Inc.
 - d. Murdock, Inc.
 - e. Prior approved equal.
 - 2. Description: Accessible, Style F, wall mounted drinking fountain. Exterior installation. Non filtered non refrigerated.

- a. Receptor(s):
 - 1) Number: Two.
 - 2) Material: Chrome-plated brass or stainless steel.
 - 3) Shape: Y shape with round bowls.
 - 4) Bubbler: One for each receptor, with adjustable stream regulator, located on deck.
- b. Controls: Push button with adjustable stream regulator.
- c. Access to Internal Components: Panel in pedestal.
- d. Supply: NPS 3/8 with ball, gate, or globe valve.
- e. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
- f. Water bottle filling station.

2.2 PRESSURE WATER COOLERS

- A. Exterior Water Cooler with bottle filling station:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Murdock M-OBR4-GRD or equal by
 - b. Elkay Manufacturing Co.
 - c. Acorn Aqua.
 - d. Haws Corporation.
 - e. Prior approved equal.
 - 2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult and child-mounting height.
 - a. Cabinet: Bilevel with two attached cabinets and with bilevel skirt kit.
 - b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 - c. Control: Push button.
 - d. Supply: NPS 3/8 with ball, gate, or globe valve.
 - e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
 - f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
 - g. Provide with auxiliary bottle filler.
 - h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

2.3 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Co.

2. MIFAB Manufacturing, Inc.
 3. Smith, Jay R. Mfg. Co.
 4. Tyler Pipe; Wade Div.
 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 6. Zurn Plumbing Products Group; Specification Drainage Operation.
 7. Prior approved equal.
- B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
1. Type II: Bilevel, hanger-type carrier with three vertical uprights.
 2. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Set freestanding and pedestal drinking fountains on floor.
- D. Set remote water coolers on floor, unless otherwise indicated.
- E. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

- C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 and 23 Section "Valves."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."
- G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

SECTION 230100 - GENERAL REQUIREMENTS FOR PLUMBING AND HVAC

PART 1 - GENERAL

1.1 GENERAL

- A. General Conditions and Division 01 apply to this Division.
- B. See Section 220100, "General Requirements for Plumbing and HVAC."

1.2 SCOPE

- A. All requirements and information contained in Division 22 Section 220100, "General Requirements for Plumbing and HVAC" shall apply to both Divisions 22 and 23.

1.3 SITE OBSERVATION

- A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.
- B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

- A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.5 COORDINATION OF WORK:

- A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.6 EQUIPMENT & MATERIALS:

- A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.7 PROJECT SUBMITTALS:

- A. See Section 220100, "General Requirements for Plumbing and HVAC."

1.8 WARRANTY GUARANTEE:

- A. See Section 220100, "General Requirements for Plumbing and HVAC."
- B. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.
- C. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.
- D. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)
- E. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.9 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

- A. See Section 220100, "General Requirements for Plumbing and HVAC."

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION 230100

SECTION 230500 - BASIC PLUMBING AND HVAC MATERIALS AND METHODS

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.
- B. Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods."

1.2 SUMMARY

- A. All requirements in Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods" shall apply to both Divisions 22 and 23.
 - 1. Equipment installation requirements common to equipment sections.

PART 2 - PRODUCTS

- 2.1 See Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods."

PART 3 - EXECUTION

- 3.1 See Division 22, Section 220500, "Basic Plumbing and HVAC Materials and Methods"

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

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. 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 requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. 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.
- 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.
 - 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

SECTION 230519 - METERS AND GAGES

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.
- B. Section 22 "Meters and Gauges.

1.2 SUMMARY

- 1. Section 22 "Meters and Gauges" shall apply to divisions 22 and 23.

PART 2 - PRODUCTS

2.1 Section 22 "Meters and Gauges."

PART 3 - EXECUTION

3.1 Section 22 "Meters and Gauges."

END OF SECTION 230519

SECTION 230523 - VALVES

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.
- B. Section 220523 Valves

1.2 SUMMARY

- A. Section 220523 "Valves" shall apply to both Divisions 22 and 23.

PART 2 - PRODUCTS

2.1 SEE SECTION 220523 "Valves"

PART 3 - EXECUTION

3.1 SEE SECTION 220523 "Valves"

END OF SECTION 230523

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section 22 "Hangers and Supports for Plumbing" shall apply to both divisions 22 and 23.

PART 2 - PRODUCTS

2.1 SEE SECTION "Hangers and supports for plumbing"

PART 3 - EXECUTION

3.1 SEE SECTION "Hangers and supports for plumbing"

END OF SECTION 230529

**SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC AND PLUMBING
PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 220548 "Vibration and Seismic Controls for HVAC and Plumbing Piping and Equipment" shall apply to both divisions 22 and 23.

1.2 SUBMITTALS

- A. See section 220548:

PART 2 - PRODUCTS

- 2.1 See section 220548 "Vibration and Seismic Controls for HVAC and Plumbing Piping and Equipment"**

PART 3 - EXECUTION

- 3.1 See section 220548 "Vibration and Seismic Controls for HVAC and Plumbing Piping and Equipment"**

END OF SECTION 230548

SECTION 230553 – IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 22 “Identification for Mechanical and Plumbing Piping and Equipment”

SUMMARY

- C. Section 22 ““Identification for Mechanical and Plumbing Piping and Equipment” shall apply to both divisions 22 and 23.

PART 2 - PRODUCTS

SEE SECTION 22 “Identification for Mechanical and Plumbing Piping and Equipment”

PART 3 - EXECUTION

SEE SECTION 22 “Identification for Mechanical and Plumbing Piping and Equipment”

END OF SECTION 230553

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - 2. HVAC equipment quantitative-performance settings.
 - 3. Verifying that automatic control devices are functioning properly.
 - 4. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.

- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of systems or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two sets of sample TAB report forms.
- F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

- B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- G. Approved TAB agencies:
1. Bonneville Test and Balance.
 2. BTC Services.
 3. Certified Test and Balance.
 4. Intermountain Test and Balance.
 5. Mechanical Testing Corporation
 6. RS Analysis.
 7. Tempco
 8. Testing and Balancing, Inc.

1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. 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. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 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.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

- M. Examine strainers for clean screens and proper perforations.
- N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- P. Examine system pumps to ensure absence of entrained air in the suction piping.
- Q. Examine equipment for installation and for properly operating safety interlocks and controls.
- R. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to indicated values.
- S. 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 system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 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 Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 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. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.

- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

3.5 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 fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer, model, and serial numbers.
 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 for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, 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. Refrigerant Coils: Measure the following data for each coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.9 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.10 PROCEDURES FOR TESTING DUCT SYSTEMS

- A. Perform duct leakage tests and duct cleanliness tests.
- B. Duct system will be considered defective if it does not pass initial tests and inspections. The sheet metal contractor shall be responsible to make corrections and repairs as necessary to pass the tests. TAB contractor shall include initial test and 1 follow up test. Any additional follow up tests required due to system not passing shall be performed by the TAB contractor at the Division 22 and 23 contractor's expense.

3.11 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.12 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.
 - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
 - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.13 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: As Work progresses, prepare 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. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Provide final report on standard AABC or NEBB forms.

3.15 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Measure sound levels at two locations.
 - e. Measure space pressure of at least 10 percent of locations.
 - f. Verify that balancing devices are marked with final balance position.
 - g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.16 ADDITIONAL TESTS

- #### **A.**
- Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - HVAC AND PLUMBING INSULATION

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.
- B. See section 220700 for HVAC and plumbing insulation.

1.2 SUMMARY

- A. Section 220700 HVAC and Plumbing insulation shall apply to insulation requirements for both division 22 and 23.
- B. Division 23 Section 233113 "Metal Ducts" for duct liners.

1.3 SUBMITTALS

- A. See section 220700.

PART 2 - PRODUCTS

- 2.1 See section 220700.**

PART 3 - EXECUTION

- 3.1 See section 220700**

END OF SECTION 230700

SECTION 231123 - FACILITY NATURAL-GAS PIPING

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. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Pressure regulators. Indicate pressure ratings and capacities.

- B. Welding certificates.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For pressure regulators to include in operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig.
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 72 inches.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - f. Prior approved equal..
 - 2. Body: Bronze, complying with ASTM B 584.

3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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. Vanguard Valves, Inc.
 - b. Safe-T-Quake.
 - c. Koso
 - d. Trembler Tech
 - e. Prior approved equal.
2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - d. Invensys.
 - e. Richards Industries; Jordan Valve Div.
 - f. Prior approved equal.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 100 psig.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Install fittings for changes in direction and branch connections.
- E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
- F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - e. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."
- M. Verify final equipment locations for roughing-in.
- N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

- P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 - 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- T. Connect branch piping from top or side of horizontal piping.
- U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- V. Do not use natural-gas piping as grounding electrode.
- W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 22 and 23 Section "Hangers and Supports."

- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 22 and 23 Section "Mechanical Identification" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Division 9 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (flat).
 - d. Color: By owner.

- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (semigloss).
 - d. Color: By owner.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping 2" and larger shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
 - 1. One-piece, bronze ball valve with bronze trim.

- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, lubricated plug valve.

END OF SECTION 231123

SECTION 232300 - REFRIGERANT PIPING

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 refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- B. Welding certificates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

- A. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Copper spring.
 - 5. Working Pressure Rating: 500 psig.

B. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

C. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

D. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

E. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.

8. Rated Flow: See drawings.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

2.3 REFRIGERANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
 5. Prior approved equal.
- B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- C. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- D. Install a full-sized, three-valve bypass around filter dryers.
- E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- F. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
1. Solenoid valves.
 2. Thermostatic expansion valves.
 3. Hot-gas bypass valves.
 4. Compressor.
- J. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- K. Install receivers sized to accommodate pump-down charge.
- L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- 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 fittings for changes in direction and branch connections.

- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 22 and 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 8 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- R. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- S. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."

- T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- U. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- V. Seal pipe penetrations through exterior walls according to Division 7 Section "Joint Sealants" for materials and methods.
- W. Identify refrigerant piping and valves according to Division 22 and 23 Section "Mechanical Identification."

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. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 22 and 23 Section "Hangers and Supports."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and flat-oval ducts and fittings.
 - 3. Double-wall round and flat-oval ducts and fittings.
 - 4. Sheet metal materials.
 - 5. Duct liner.
 - 6. Sealants and gaskets.
 - 7. Hangers and supports.
 - 8. Seismic-restraint devices.
- B. Related Sections:
 - 1. Division 22 and 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 - 2. Division 22 and 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.
 - 1. Static-Pressure Classes:
 - a. Supply Ducts (except in Mechanical Rooms): 2-inch wg.
 - b. Supply Ducts (Upstream from Air Terminal Units): 3-inch wg.
 - c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
 - d. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg.
 - e. Return Ducts (Negative Pressure): 1-inch wg.
 - f. Exhaust Ducts (Negative Pressure): 1-inch wg.
 - 2. Leakage Class:

- a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
 - b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
 - c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
 - d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
 2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
 3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:
 1. Liners and adhesives.
 2. Sealants and gaskets.
 3. Seismic-restraint devices.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 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.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

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 1-4, "Transverse (Girth) 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 1-5, "Longitudinal Seams - Rectangular Ducts," 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 2, "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 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
 - f. Metco.
 - g. Prior approved equal.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- 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. Lindab Inc.
 2. McGill AirFlow LLC.
 3. SEMCO Incorporated.
 4. Sheet Metal Connectors, Inc.
 5. Metco.
 6. Prior approved equal.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct) of the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.

2.4 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.
- 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.

2.5 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - e. Prior approved equal.
 - f. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
4. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors.

B. Insulation Pins and Washers:

1. 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.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.

6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 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. 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.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 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 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

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 round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 22 Section "Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

- A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:
 - a. Ducts that are located directly in zones they serve.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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.

3.4 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 22 and 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
 - 2. Test the following systems:
 - a. Supply air.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before insulation application.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 22 and 23 Section "Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel:

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts: Galvanized steel.

3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
- C. Liner:
1. Supply- and Return-Air Ducts: Fibrous glass, Type I.
- D. Double-Wall Duct Interstitial Insulation:
1. Supply- and Return-Air Ducts: 1 inch thick.
- E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

- 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

G. Duct Schedule

1. Rectangular duct with liner:
 - a. Low pressure supply and return.
2. Rectangular duct wrapped with insulation:
 - a. Low pressure exhaust and fresh air.
3. Single wall round with wrapped insulation.
 - a. Low pressure supply and return.
4. Double wall round and flat oval:
 - a. Medium pressure supply (upstream of VAV).

END OF SECTION 233113

SECTION 233300 - DUCT ACCESSORIES

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. Backdraft dampers.
 - 2. Volume dampers.
 - 3. High Efficiency Take-Offs.
 - 4. Motorized control dampers.
 - 5. Turning vanes.
 - 6. Duct-mounting access doors.
 - 7. Flexible connectors.
 - 8. Flexible ducts.
 - 9. Duct accessory hardware.
- B. Related Sections include the following:
 - 1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for electric and pneumatic damper actuators.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. High Efficiency Take-Offs.
 - 4. Motorized control dampers.
 - 5. Turning vanes.
 - 6. Duct-mounting access doors.
 - 7. Flexible connectors.
 - 8. Flexible ducts.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

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 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- 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 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. CESCO Products.
 - 4. Duro Dyne Corp.
 - 5. Greenheck.
 - 6. Penn Ventilation Company, Inc.

7. Prefco Products, Inc.
 8. Ruskin Company.
 9. Tamco
 10. Vent Products Company, Inc.
 11. Air Rite.
 12. Prior approved equal.
- B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- C. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.
- D. Blades: 0.025-inch- thick, roll-formed aluminum.
- E. Blade Seals: Neoprene.
- F. Blade Axles: Galvanized steel.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

- A. Manufacturers:
1. Air Balance, Inc.
 2. American Warming and Ventilating.
 3. Clifco
 4. Flexmaster U.S.A., Inc.
 5. Leader
 6. McGill AirFlow Corporation.
 7. METALAIRE, Inc.
 8. Nailor Industries Inc.
 9. Penn Ventilation Company, Inc.
 10. Ruskin Company.
 11. Vent Products Company, Inc.
 12. Air Rite.
 13. Greenheck.
 14. Prior approved equal.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. Standard Volume Dampers: Opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
 3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Bearings: Oil-impregnated bronze.
 8. Tie Bars and Brackets: Aluminum.
 9. Tie Bars and Brackets: Galvanized steel.
- D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 HIGH EFFICIENCY TAKE-OFF

- A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.
- B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.
- C. Manual Volume Damper:
1. Single blade, 22 ga minimum.
 2. 3/8 inch minimum square rod with brass damper bearings at each end.
 3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.
- D. Approved Manufacturers:
1. HETD-L by Daniel Manufacturing.
 2. STO by Flexmaster USA Inc.
 3. HET by Sheet Metal Connectors Inc.
 4. Hercules.
 5. Clifco
 6. Air-Rite.

7. Prior approved equal.

2.6 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.
6. McGill AirFlow Corporation.
7. METALAIR, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Tamco
12. Vent Products Company, Inc.
13. Air Rite.
14. Prior approved equal.

B. General Description: AMCA-rated, opposed-blade design; minimum of 0.1084-inch-thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch-thick, galvanized-steel damper blades with maximum blade width of 8 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Provide closed-cell neoprene edging.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Available Manufacturers:

- a. Ductmate Industries, Inc.
- b. Duro Dyne Corp.
- c. METALAIR, Inc.
- d. Ward Industries, Inc.
- e. Prior approved equal.

- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.8 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
 - 1. Manufacturers:
 - a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Flexmaster U.S.A., Inc.
 - e. Greenheck.
 - f. McGill AirFlow Corporation.
 - g. Nailor Industries Inc.
 - h. Ventfabrics, Inc.
 - i. Ward Industries, Inc.
 - j. Air Rite.
 - k. Prior approved equal.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Provide number of hinges and locks as follows:
 - a. Less Than 12 Inches Square: Secure with two sash locks.
 - b. Up to 18 Inches Square: Two hinges and two sash locks.
 - c. Up to 24 by 48 Inches: Three hinges and two compression latches.
 - d. Sizes 24 by 48 Inches and Larger: One additional hinge.
- C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- D. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Corp.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.
 - 5. Prior approved equal.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.
- D. 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.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.10 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Flexmaster U.S.A., Inc.
 - 2. Hart & Cooley, Inc.
 - 3. McGill AirFlow Corporation.
 - 4. Themaflex.
 - 5. Quietflex
 - 6. Prior approved equal.
- B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 210 deg F.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- F. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
 - 3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
 - 4. On sides of ducts where adequate clearance is available.
- I. Install the following sizes for duct-mounting, rectangular access doors:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 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.
- J. Install the following sizes for duct-mounting, round access doors:
 - 1. One-Hand or Inspection Access: 8 inches in diameter.
 - 2. Two-Hand Access: 10 inches in diameter.
 - 3. Head and Hand Access: 12 inches in diameter.

- 4. Head and Shoulders Access: 18 inches in diameter.
- 5. Body Access: 24 inches in diameter.

- K. Label access doors according to Division 22 and 23 Section "Mechanical Identification."

- L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

- M. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

- N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

- O. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

- P. Connect flexible ducts to metal ducts with adhesive.

- Q. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.

- B. Adjust fire and smoke dampers for proper action.

- C. Final positioning of manual-volume dampers is specified in Division 22 and 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233300

SECTION 233423 – EXHAUST FANS

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. Ceiling Mounting Ventilator.

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 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For power ventilators to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTING VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Loren Cook Company. Gemini or equal by.
 - 2. American Coolair Corp.
 - 3. Carnes Company HVAC.
 - 4. Greenheck.
 - 5. JencoFan; Div. of Breidert Air Products.
 - 6. NuTone Inc.
 - 7. Penn Ventilation.
 - 8. Twin City
 - 9. Prior approved equal.
- B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- C. Housing: Steel, lined with acoustical insulation.
- D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Accessories:
 - 1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - 2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 3. Motion Sensor: Motion detector with adjustable shutoff timer.
 - 4. Manufacturer's standard roof jack or wall cap, and transition fittings.
- H. Capacities and Characteristics: See drawings.

2.2 MOTORS

- A. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops. Insert device having a static deflection of 1 inch. Vibration-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Division 22 and 23 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 22 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" 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

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

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. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 GRILLES AND REGISTERS

- A. Adjustable Bar Side Wall Supply Grille:
 - 1. Products:
 - a. Carnes; RVEA.

- b. Krueger; 5815.
- c. METALAIRE, Inc., Metal Industries Inc.; 422.
- d. Price Industries; LBM R.
- e. Titus; 1707.
- f. Tuttle & Bailey; VF5.
- g. Or equal by:

- 1) A-J Manufacturing Co., Inc.
- 2) Anemostat; a Mestek Company.
- 3) Dayus Register & Grille.
- 4) Hart & Cooley, Inc.; Hart & Cooley Div.
- 5) Nailor Industries of Texas Inc.

- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white.
- 4. Face Blade Arrangement: Adjustable horizontal spaced 1/4 inch apart.
- 5. Frame: 1 inch wide.

B. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:

1. Products:

- a. Carnes; RSLA.
- b. Krueger; S85H.
- c. Price Industries; 535.
- d. Titus; 355RL.
- e. Tuttle & Bailey; T70D.
- f. Or equal by:

- 1) A-J Manufacturing Co., Inc.
- 2) Anemostat; a Mestek Company.
- 3) Dayus Register & Grille.
- 4) Hart & Cooley, Inc.; Hart & Cooley Div.
- 5) Nailor Industries of Texas Inc.

- 2. Material: Steel.
- 3. Finish: Baked enamel, white.
- 4. Face Arrangement: 1/2 inch horizontal blade spacing.
- 5. Frame: 1-1/4 inches wide.

C. Low Sidewall Return Grilles

- 1. Finish – Standard white baked enamel.
- 2. Zero degree deflection.
- 3. Approved Manufacturers And Models

- a. Carnes - RSHA
- b. J & J - S-590
- c. Krueger - S480H
- d. Metalaire - HD-RH
- e. Price - 90-L
- f. Titus - 30RL or 30 SL

- g. Tuttle & Bailey - T110 or equal by
 - h. Agitair
 - i. Anemostat
 - j. Barber Colman
 - k. Environmental Air Products
 - l. Air Control Products
 - m. Nailor
- D. Floor Grilles:
- 1. Finish: Clear anodized.
 - 2. Approved Products:
 - a. Carnes: CCJB (with mitered corners welded on face and sanded).
 - b. J & J: 2500 with Frame 10.
 - c. Krueger: 1500F.
 - d. Metal*Aire: 2000F.
 - e. Nailor: 49-240-FN-MM.
 - f. Price: LBP-25B.
 - g. Titus: CT-540.
 - h. Tuttle & Bailey: LFD.
- E. Door Grilles:
- 1. Finish: Baked enamel. Match door as closely as possible as approved by Architect.
 - 2. Approved Products:
 - a. Carnes.
 - b. J & J.
 - c. Krueger.
 - d. Metal*Aire.
 - e. Nailor: 610GD.
 - f. Price: STGI-BF.
 - g. Titus: T-700.
 - h. Tuttle & Bailey.

2.3 LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

- 1. Manufacturers:
 - a. Air Research Diffuser Products, Inc.
 - b. Anemostat; a Mestek Company.
 - c. Carnes.
 - d. Hart & Cooley, Inc.; Hart & Cooley Div.
 - e. Krueger.
 - f. METALAIR, Inc.; Metal Industries Inc.
 - g. Nailor Industries of Texas Inc.
 - h. Price Industries.
 - i. Titus.
 - j. Tuttle & Bailey.
 - k. Prior approved equal.

2. Material - Shell: Steel, insulated.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel.
5. Finish - Pattern Controller: Baked enamel.
6. Finish - Tees: Baked enamel, white.
7. Slot Width: As indicated on drawings.
8. Number of Slots: As indicated on drawings.

2.4 CEILING DIFFUSER OUTLETS

A. Round Ceiling Diffuser Duct Mounted Exposed:

1. Manufacturers:
 - a. Price RCD or equal by:
 - 1) Anemostat; a Mestek Company.
 - 2) Carnes.
 - 3) Hart & Cooley, Inc.; Hart & Cooley Div.
 - 4) METALAIRE, Inc.; Metal Industries Inc.
 - 5) Nailor Industries of Texas Inc.
 - 6) Titus.
 - 7) Tuttle & Bailey.
 - 8) Prior approved equal.
2. Material: Heavy gauge spun steel.
3. Finish: Baked enamel, color selected by Architect.
4. Face Style: Three cone.
5. Pattern: Two position horizontal.

B. Rectangular and Square Ceiling Diffusers:

1. Products:
 - a. Carnes.
 - b. Krueger.
 - c. METALAIRE, Inc., Metal Industries Inc.
 - d. Price Industries; SPD or equal by.
 - e. Titus.
 - f. Tuttle & Bailey.
 - g. A-J Manufacturing Co., Inc.
 - h. Anemostat; a Mestek Company.
 - i. Hart & Cooley, Inc.; Hart & Cooley Div.
 - j. Nailor Industries of Texas Inc.
 - k. Prior approved equal.
2. Material: Steel.
3. Finish: Baked enamel, white.

2.5 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 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 level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233714 - LOUVERS AND VENTS

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. Section Includes:
 - 1. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.
- C. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 PERFORMANCE REQUIREMENTS

- A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
 - 3. Wiring Diagrams: For power, signal, and control wiring for motorized adjustable louvers.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of metal finish required.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."
 - 3. AWS D1.6, "Structural Welding Code - Stainless Steel."
- C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- D. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: **ASTM B 221**, Alloy 6063-T5, T-52, or T6.

- B. Aluminum Sheet: **ASTM B 209**, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.
- D. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
 - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 - 3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
 - 4. For fastening stainless steel, use 300 series stainless-steel fasteners.
 - 5. For color-finished louvers, use fasteners with heads that match color of louvers.
- E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Include supports, anchorages, and accessories required for complete assembly.
- C. Provide subsills made of same material as louvers or extended sills for recessed louvers.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Nondrainable-Blade Louver:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ruskin Company; Tomkins PLC. Model ELF811 or equivalent.
 - b. Airolite Company, LLC (The).
 - c. American Warming and Ventilating, Inc.; a Mestek company.
 - d. Arrow United Industries; a division of Mestek, Inc.
 - e. Carnes Company, Inc.
 - f. Cesco Products; a division of Mestek, Inc.
 - g. Greenheck Fan Corporation.
 - h. NCA Manufacturing, Inc.

- i. Pottrof
 - j. Prior approved equal.
- 2. Fabrication: Continuous blade style.
 - a. Frame:
 - 1) Frame Depth: 4 inches (102mm).
 - 2) Material: Extruded aluminum, Alloy 6063-T5.
 - 3) Wall Thickness: 0.125 inch (3.2mm), nominal.
 - b. Blades:
 - 1) Style: Horizontal "K".
 - 2) Material: Formed aluminum, Alloy 6063-T5.
 - 3) Wall Thickness: 0.125 inch (3.2 mm), nominal.
 - 4) Angle: 45 degrees.
 - 5) Centers: 4-1/2 inches (114 mm), nominal.
 - 6) Continuous Blade Style – Design incorporates visible mullions or frames at the perimeter of the louver only. Rear-mounted hidden blade supports are utilized at section joints and at intermediate locations as needed. Louver blade sightlines are not interrupted at section joints or blade support locations. The rear-mounted blade support depth varies depending on louver height and the design windload.
 - c. Assembly:
 - 1) Factory assembled louver components. Mechanically fastened construction.

B. Performance Data:

- 1. Performance Ratings:
 - a. Based on testing 48 inch by 48 inch (1219 mm by 1219 mm) size unit in accordance with AMCA 500.
- 2. Free Area: 44 percent, nominal.
- 3. Maximum Recommended Air Flow through Free Area: 707 feet per minute (214 m/min).
- 4. Air Flow: 5027 cubic feet per minute (142 cu. m/min).
- 5. Maximum Pressure Drop (Intake): .06 inches w.g. (14.9 Pa).
- 6. Water Penetration: Maximum of 0.01 ounces per square foot (3.1 g/sm) of free area at an air flow of 707 feet per minute (214 m/min) free area velocity when tested for 15 minutes.

C. Design Load: Incorporate structural supports required to withstand wind load of:

- 1. 20 lb/sf (0.96 kPa).

2. Per Code.
3. Louvers shall be factory engineered to withstand the specified seismic loads.
 - a. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction.

2.4 ACCESSORIES

- A. Aluminum Insulated Blank-Off Panels: 1 inch (25 mm), aluminum skin, insulated core, factory installed with removable screws and neoprene gaskets.
- B. Hinged Frame: Continuous piano hinge attached to angle subframe.
- C. Hinged Frame: Continuous piano hinge attached to channel subframe.
- D. Bird Screen:
 1. Aluminum: Aluminum, 3/4 inch by 0.051 inch (19 mm by 1.3 mm), expanded, flattened.
 2. Aluminum: Aluminum, 5/8 inch by 0.040 inch (16 mm by 1 mm), expanded, flattened.
 3. Aluminum: Aluminum, 1/2 inch mesh by 0.063 inch (13 mm mesh by 1.6 mm), intercrimp.
 4. Steel: Galvanized steel, 1/2 inch mesh by 19 gage (13 mm mesh by 1.1 mm), intercrimp.
 5. Frame: Removable, rewireable.

2.5 FINISHES

- A. Kynar:
 1. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
 2. Standard 2-coat.
 3. Pearledize 70 (2-coat mica).
- B. 50 percent Floropolymer-Based Painted Finishes:
 1. Coating shall conform to AAMA 2604, sections 4.2 and 4.3. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
 2. Baked Enamel.
 3. Pearledize 50 (2-coat mica).
- C. Color for Kynar Finish:
 1. Color: Custom. Refer to Drawings.
- D. Anodized Finishes:

1. Class 2 Clear Anodized.
 - a. Comply with Aluminum Association AA-C22A41. Clear anodized finish 215-R1.
 - b. Apply finish following chemical etching and pretreatment.
 - c. Minimum Thickness: 0.7 mils (0.018 mm), 60 minute anodizing process.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 233714

SECTION 235216 - CONDENSING UNITS

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 air-cooled condensing units.

1.3 SUBMITTALS

- A. Product Data: For each condensing unit, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that condensing units, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For condensing units to include in operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - 1. Units shall be designed to operate with HCFC-free refrigerants.
- D. ASME Compliance: Fabricate and label water-cooled condensing units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- C. Coordinate location of piping and electrical rough-ins.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.
 - b. Condenser coil leak.
 - 2. Warranty Period: Four years from date of Substantial Completion.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONDENSING UNITS, AIR COOLED, 1 TO 5 TONS

- A. Manufacturers:
 - 1. Carrier Corporation; Carrier Air Conditioning Div.
 - 2. Trane Co. (The); Worldwide Applied Systems Group.
 - 3. York International Corp.
 - 4. Prior approved equal.
- B. Description: Factory assembled and tested, consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.
- C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
 - 1. Motor: Includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
 - 3. Accumulator: Suction tube.
 - 4. Refrigerant Charge: R-410A.
- D. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.
- E. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings.
- F. Accessories:
 - 1. Crankcase heater.
 - 2. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
 - 3. Electronic programmable thermostat to control condensing unit and evaporator fan.
 - 4. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
 - 5. Filter-dryer.
 - 6. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
 - 7. Liquid-line solenoid.

8. Low Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F with time-delay relay to bypass low-pressure switch.
 9. Low Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F with time-delay relay to bypass low-pressure switch.
 10. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
 11. PE mounting base to provide a permanent foundation.
 12. Precharged and insulated suction and liquid tubing.
 13. Sound Hood: Wraps around sound attenuation cover for compressor.
 14. Thermostatic expansion valve.
 15. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
- G. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.3 MOTORS

- A. General requirements for motors are specified in Division 22 and 23 Section "Motors."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 16 Sections.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate condensing units according to ARI.
1. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
 2. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- B. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

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 condensing units.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Install condensing units on concrete base. Concrete base is specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.
- C. Concrete Bases:
 - 1. Install dowel rods to connect concrete base to concrete slab. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
 - 2. For equipment supported on structural slab, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. Install roof-mounting units on equipment supports specified in Division 7.
- E. Vibration Isolation: Mount condensing units on rubber pads with a minimum deflection of 1/4 inch. Vibration isolation devices and installation requirements are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
- F. Maintain manufacturer's recommended clearances for service and maintenance.
- G. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.
- D. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section "Refrigerant Piping."
- E. Connect refrigerant and condenser-water piping to water-cooled condensing units. Maintain clear tube removal space. Refrigerant piping and specialties are specified in Division 22 and 23 Section "Refrigerant Piping" and condenser-water piping and specialties are specified in Section "Domestic Water Piping."
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."
- G. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform electrical test and visual and mechanical inspection.
 - 2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Verify proper airflow over coils.
- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- C. Remove and replace malfunctioning condensing units and retest as specified above.

3.5 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Inspect for physical damage to unit casing.
 - 2. Verify that access doors move freely and are weathertight.
 - 3. Clean units and inspect for construction debris.

4. Verify that all bolts and screws are tight.
 5. Adjust vibration isolation and flexible connections.
 6. Verify that controls are connected and operational.
- B. Lubricate bearings on fans.
 - C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
 - D. Adjust fan belts to proper alignment and tension.
 - E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
 - F. Measure and record airflow over coils.
 - G. Verify proper operation of condenser capacity control device.
 - H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
 - I. After startup and performance test, lubricate bearings and adjust belt tension.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION 235216

SECTION 235400 - FURNACES

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. Gas-fired, condensing furnaces and accessories complete with controls.
 - 2. Air filters.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each of the following:
 - 1. Furnace.
 - 2. Air filter.
 - 3. Refrigeration components.
- 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. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For each furnace to include in operation, and maintenance manuals for each of the following:
 - 1. Furnace and accessories complete with controls.
 - 2. Refrigeration components.
- D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:
 - 1. Warranty Period, Commencing on Date of Substantial Completion:
 - a. Furnace Heat Exchanger: 10 years.
 - b. Integrated Ignition and Blower Control Circuit Board: Five years.
 - c. Draft-Inducer Motor: Five years.
 - d. Refrigeration Compressors: 10 years.
 - e. Evaporator and Condenser Coils: Five years.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Disposable Air Filters: Furnish two complete sets.

PART 2 - PRODUCTS

2.1 GAS-FIRED FURNACES, CONDENSING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier MVB or equal by.
 - 2. Trane.
 - 3. York.
 - 4. Tempstar.
 - 5. Airease.
 - 6. Prior approved equal.
- B. General Requirements for Gas-Fired, Condensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.

- C. Cabinet: Steel.
 - 1. Cabinet interior around heat exchanger shall be factory-installed insulation.
 - 2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
 - 3. Factory paint external cabinets in manufacturer's standard color.
- D. Fan: Centrifugal, factory balanced, resilient mounted, direct drive, variable speed.
 - 1. Special Motor Features: Variable speed, premium efficiency, as defined in Division 22 and 23 Section "Motors," and with internal thermal protection and permanent lubrication.
 - 2. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - 3. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.
- E. Type of Gas: Natural.
- F. AFUE: 90 percent.
- G. Heat Exchanger:
 - 1. Primary: Aluminized steel.
- H. Burner:
 - 1. Gas Valve: 100 percent safety two-stage main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
 - 2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.
- I. Gas-Burner Safety Controls:
 - 1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
 - 2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
 - 3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
- J. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.
- K. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories.
- L. Accessories:
 - 1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through outside wall or roof.
 - 2. Plastic Vent Materials.

- a. CPVC Plastic, Schedule 40 Pipe: ASTM F 441/F 441M.
 - 1) CPVC Plastic, Schedule 40 Fittings: ASTM F 438, socket type.
 - 2) CPVC Solvent Cement: ASTM F 493.
- b. PVC Plastic, Schedule 40 Pipe: ASTM D 1785.
 - 1) PVC Plastic, Schedule 40 Fittings: ASTM D 2466, socket type.
 - 2) PVC Solvent Cement: ASTM D 2564.
- M. Capacities and Characteristics: See drawings.

2.2 AIR FILTERS

- A. Disposable Filters: 1-inch- thick, disposable, fiberglass type in sheet metal frame.

2.3 REFRIGERATION COMPONENTS

- A. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet.
 - 1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
- B. Refrigerant Piping: Comply with requirements in Division 23 Section "Refrigerant Piping."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.
- B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
 - 1. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.
- C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.
 - 1. Anchor furnace to substrate to resist code-required seismic acceleration.
- D. Controls: Install thermostats and humidistats at mounting height of 60 inches above floor.
- E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

3.3 CONNECTIONS

- A. Gas piping installation requirements are specified in Division 22 Section "Fuel Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors. Type B vents and their installation requirements are specified in Division 23 Section "Breechings, Chimneys, and Stacks."
- D. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - 3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

- c. PVC Pressure Piping: Join schedule number ASTM D 1785, 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.
- 4. Slope pipe vent back to furnace or to outside terminal.
- E. Connect ducts to furnace with flexible connector. Comply with requirements in Division 22 and 23 Section "Duct Accessories."
- F. Connect refrigerant piping to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.
 - 1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
 - 2. 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.
 - 3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- G. Comply with requirements in Division 22 and 23 Section "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform electrical test and visual and mechanical inspection.
 - 2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
 - 4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Inspect for physical damage to unit casings.

2. Verify that access doors move freely and are weathertight.
 3. Clean units and inspect for construction debris.
 4. Verify that all bolts and screws are tight.
 5. Adjust vibration isolation and flexible connections.
 6. Verify that controls are connected and operational.
- B. Adjust fan belts to proper alignment and tension.
 - C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.
 - D. Measure and record airflows.
 - E. Verify proper operation of capacity control device.
 - F. After startup and performance test, lubricate bearings.

3.6 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

- A. After completing installation, clean furnaces internally according to manufacturer's written instructions.
- B. Install new filters in each furnace within 14 days after Substantial Completion.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 235400

SECTION 235523 - GAS-FIRED RADIANT HEATERS

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 gas-fired, tubular infrared radiant heaters.

1.3 SUBMITTALS

- A. Product Data: For each type of gas-fired radiant heater indicated. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings: For gas-fired radiant heaters; signed and sealed by a qualified professional engineer. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired radiant heaters, as well as procedures and diagrams.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which equipment will be attached.
 - 2. Items penetrating roof and the following:
 - a. Vent and gas piping rough-ins and connections.
- D. Manufacturer Seismic Qualification Certification: Submit certification that gas-fired radiant heaters, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

- a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For gas-fired radiant heaters to include in operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of gas-fired radiant heater that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Burner Igniters: One hot-surface burner igniter(s) for each style of gas-fired radiant heater furnished.

PART 2 - PRODUCTS

2.1 TUBULAR INFRARED HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Calcana Industries Ltd.
 - 2. Combustion Research Corporation.
 - 3. Gas-Fired Products Inc.; Space-Ray Div.
 - 4. Reznor/Thomas & Betts Corporation.
 - 5. Roberts-Gordon, Inc.
 - 6. Schwank Inc.
 - 7. Solaronics, Inc.
 - 8. Superior Radiant Products
 - 9. Sterling HVAC Products; Div. of Mestek Technology Inc.
 - 10. Prior approved equal.
- C. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.20/CSA 2.34.
- D. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- E. Combustion Tubing: 4-inch- diameter stainless steel with high-emissivity, high-temperature, corrosion-resistant external finish.
- F. Tubing Connections: Stainless-steel couplings or flared joints with stainless-steel draw bolts.
- G. Reflector: Polished aluminum, 97 percent minimum reflectivity, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Provide for rotating reflector or heater around a horizontal axis for minimum 30-degree tilt from vertical.
 - 1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
 - 2. Include hanger kit.
- H. Burner Safety Controls:
 - 1. Gas Control Valve: Single-stage, regulated redundant 24-V ac gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

2. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.
 3. Control Panel Interlock: Stops burner if panel is open.
 4. Indicator Lights: Burner-on indicator light.
- I. Burner and Emitter Type: Gravity-vented power burner, with the following features:
1. Emitter Tube: 4-inch- diameter, aluminized-steel tubing with sight glass for burner and pilot flame observation.
 2. Venting: Unvented.
 3. Burner/Ignition: Power gas burner with electronic spark and electronic flame safety.
 4. Burner/Ignition: Stainless-steel burner cup and head with balanced-rotor draft fan and direct-sensing, hot-surface ignition.
 5. Combustion-Air Connection: Duct connection for combustion air to be drawn directly from outdoors by burner fan.
- J. Capacities and Characteristics: See schedules

2.2 CONTROLS

- A. Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
- B. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
1. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect gas-fired radiant heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.
1. Spring hangers and seismic restraints are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
 2. Restrain the unit to resist code-required horizontal acceleration. Seismic restraints are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
- C. Maintain manufacturers' recommended clearances to combustibles.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to gas-fired radiant heaters to allow service and maintenance.
- C. Gas Piping: Comply with Division 22 and 23 Section "Fuel Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
- D. Vent Connections: Comply with Division 22 and 23 Section "Breechings, Chimneys, and Stacks."
- E. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
 - 1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 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. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

- A. Adjust initial temperature set points.

- B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired radiant heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 235523

SECTION 235533 - FUEL-FIRED UNIT HEATERS

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 gas-fired unit heaters.

1.3 SUBMITTALS

- A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings: For fuel-fired unit heaters; signed and sealed by a qualified professional engineer. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of fuel-fired unit heaters, as well as procedures and diagrams.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which equipment will be attached.
 - 2. Items penetrating roof and the following:
 - a. Vent and gas piping rough-ins and connections.
- D. Manufacturer Seismic Qualification Certification: Submit certification that fuel-fired unit heaters, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For fuel-fired unit heaters to include in operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchanger of fuel-fired unit heater that fails in materials or workmanship within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fan Belts: One for each belt-driven fan size.

PART 2 - PRODUCTS

2.1 GAS-FIRED UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lennox Industries, Inc.
 - 2. Modine Manufacturing Company.
 - 3. Reznor/Thomas & Betts Corporation.
 - 4. Sterling HVAC Products; Div. of Mestek Technology Inc.
 - 5. Prior approved equal.
- C. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
- D. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- E. Type of Venting: Powered vented.
- F. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
 - 1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
 - 2. Suspension Attachments: Reinforce suspension attachments at connection to fuel-fired unit heaters.
 - a. Seismic Fabrication Requirements: Fabricate suspension attachments of fuel-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls" when fuel-fired unit heater is anchored to building structure.
- G. Heat Exchanger: Aluminized steel.
- H. Burner Material: Aluminized steel with stainless-steel inserts.
- I. Unit Fan: Formed-steel propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
 - 1. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 - 2. General requirements for motors are specified in Division 22 and 23 Section "Motors."

- a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 22 and 23 Section "Motors."
 - b. 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.
 - c. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- J. Unit Fan: Steel, centrifugal fan dynamically balanced and resiliently mounted.
 - 1. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 2. General requirements for motors are specified in Division 22 and 23 Section "Motors."
 - a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 22 and 23 Section "Motors."
 - b. 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.
 - c. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- K. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 - 1. Gas Control Valve: Two stage.
 - 2. Ignition: Electronically controlled electric spark with flame sensor.
 - 3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
 - 4. Vent Flow Verification: Flame rollout switch.
 - 5. Control transformer.
 - 6. High Limit: Thermal switch or fuse to stop burner.
 - 7. Thermostats: Devices and wiring are specified in Division 22 and 23 Section "HVAC Instrumentation and Controls."
 - 8. Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
 - 9. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
 - 10. Thermostat: Single-stage type with duct-mounting sensor and 50 to 90 deg F operating range.
 - 11. Thermostat: 2-stage type with duct-mounting sensor and 50 to 90 deg F operating range.
- L. Discharge Louvers: Independently adjustable horizontal blades.

M. Accessories:

1. Vertical discharge louvers.
2. Discharge Nozzle: Discharge at 50 to 90 degrees from horizontal.
3. Four-point suspension kit.
4. Summer fan switch.
5. Unit-mounted thermostat bracket.
6. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
7. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.

N. Capacities and Characteristics: See schedules

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
1. Restrain the unit to resist code-required horizontal acceleration.
- C. Substrate-Mounted Units: Provide supports connected to substrate. Secure units to supports.
1. Spring hangers and seismic restraints are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
 2. Anchor the unit to resist code-required horizontal acceleration.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.
- C. Gas Piping: Comply with Division 22 and 23 Section "Fuel Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
- D. Fuel Oil Piping: Comply Division 22 and 23 Section "Fuel Oil Piping." Connect to fuel oil supply and return piping with shutoff valve and union at each connection.

- E. Vent Connections: Comply with Division 22 and 23 Section "Breechings, Chimneys, and Stacks."
- F. Electrical Connections: Comply with applicable requirements in Division 22 and 23 Sections.
 - 1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 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. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

- A. Adjust initial temperature set points.
- B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-fired unit heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 235533

SECTION 236313 - AIR-COOLED CONDENSERS

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 packaged, air-cooled condensers for outdoor installation.

1.3 SUBMITTALS

- A. Product Data: For each air-cooled condenser, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Schematic drawing, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which air-cooled condensers will be attached.
 - 2. Liquid and vapor pipe sizes.
 - 3. Refrigerant specialties.
 - 4. Piping including connections, oil traps, and double risers.
 - 5. Compressors.
 - 6. Evaporators.
- D. Manufacturer Seismic Qualification Certification: Submit certification that air-cooled condensers, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

- a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For air-cooled condensers to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-cooled condensers and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- C. Coordinate location of refrigerant piping and electrical rough-ins.

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:

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bohn Refrigeration Products; Heatcraft, Inc.
 2. Carrier Corporation; Carrier Air Conditioning Div.
 3. Colmac Coil Manufacturing, Inc.
 4. Coolenheat Inc.
 5. Dunham-Bush, Inc.
 6. Engineered Air.
 7. McQuay International.
 8. Trane Co. (The); Worldwide Applied Systems Group.
 9. York International Corp.
 10. USA Coil & Air Inc.
 11. Prior approved equal.

2.2 MANUFACTURED UNITS

- A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
- B. Condenser Coil: Seamless copper-tube, finned coil; factory tested at 425 psig.
1. Coil Fin: Aluminum.
 2. Circuit: To match compressors with liquid subcooling coil.
 3. Refrigerant Accessories: Provide receiver, pressure control, and solenoid valve for each circuit.
- C. Condenser Fans and Drives: Propeller fans with aluminum or galvanized-steel fan blades, for vertical air discharge; directly driven with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.
- D. Condenser Fans and Drives: Forward-curved centrifugal fans for vertical air discharge.
1. Fan on steel shaft with self-aligning ball bearings.
 2. V-belt drive with minimum of two belts; variable pitch drive pulley.
 3. Motor mounted on adjustable slide base.
- E. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 115-V control transformer, if required; magnetic contactors for condenser fan motors and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
- F. Unit Casings: Galvanized or zinc-coated steel treated and finished with manufacturer's standard paint coating, designed for outdoor installation with weather protection for components and controls, and with the following:
1. Removable panels for access to controls, condenser fans, motors, and drives.
 2. Plated-steel fan guards.
 3. Lifting eyes.
 4. Removable legs.

5. 1-inch- thick inlet filter.

2.3 MOTORS

- A. General requirements for motors are specified in Division 22 and 23 Section "Motors."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate air-cooled condensers according to ARI 210/240.
- B. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

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 air-cooled condensers.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Install air-cooled condensers on concrete base. Concrete base is specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.
- C. Concrete Bases:
 1. Install dowel rods to connect concrete base to concrete slab. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.

2. For equipment supported on structural slab, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. Install roof-mounting units on equipment supports specified in Division 7.
- E. Vibration Isolation: Mount air-cooled condensers on rubber pads with a minimum deflection of 1/4 inch. Vibration isolation devices and installation requirements are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
- F. Support suspended units from structure using threaded steel rods.
- G. Maintain manufacturer's recommended clearances for service and maintenance.
- H. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Division 22 and 23 Section "Refrigerant Piping."
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."
- E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Perform electrical test and visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Verify proper airflow over coils.

- B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- C. Remove and replace malfunctioning air-cooled condensers and retest as specified above.

3.5 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Inspect for physical damage to unit casing.
 - 2. Verify that access doors move freely and are weathertight.
 - 3. Clean units and inspect for construction debris.
 - 4. Verify that all bolts and screws are tight.
 - 5. Adjust vibration isolation and flexible connections.
 - 6. Verify that controls are connected and operational.
- B. Lubricate bearings on fans.
- C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
- D. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
- E. Measure and record airflow over coils.
- F. Verify proper operation of capacity control device.
- G. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- H. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-cooled condensers. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 236313

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes cooling and heating packaged rooftop units.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:
 - 1. Design Calculations: For selecting and designing restrained vibration isolation roof-curb rails.
 - 2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Startup service reports.
- D. Operation and Maintenance Data: For rooftop units to include in operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Units shall be designed to operate with HCFC-free refrigerants.

1.6 COORDINATION

- A. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- B. Coordinate size, location, and installation of rooftop unit manufacturer's roof curbs and equipment supports with roof Installer.
 - 1. Coordinate installation of restrained vibration isolation roof-curb rails, which are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AAON, Inc.

2. Carrier.
3. Trane.
4. York.
5. Prior approved equal.

2.2 CABINET

- A. Construction: Single wall.
- B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.
- C. Interior Casing: Galvanized steel.
- D. Base Rails: Galvanized-steel rails for mounting on roof curb.
- E. Service Doors: Hinged access doors with neoprene gaskets.
- F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
 1. Thickness: 1 inch.
 2. Insulation Adhesive: Comply with ASTM C 916, Type I.
 3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
- G. Condensate Drain Pans: Formed sections of galvanized-steel sheet designed for self-drainage. Fabricate pans with slopes to preclude buildup of microbial slime.
- H. Provide with auxiliary hail guards to protect the condenser fins from storm damage.

2.3 SUPPLY-AIR FAN

- A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings.
- B. Motor: Open dripproof, single-speed motor.
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
- D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with elastomeric isolators.

2.4 REFRIGERATION SYSTEM

- A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

- B. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.
- C. EER and COP: as defined by ASHRAE/IESNA 90.1-2004, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- D. Refrigerant: R-410A.
- E. Refrigeration System Specialties:
 - 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant dryer.
 - 3. High-pressure switch.
 - 4. Low-pressure switch.
 - 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
 - 6. Brass service valves installed in discharge and liquid lines.
 - 7. Operating charge of refrigerant.
- F. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
 - 1. Capacity Reduction: Circuit coils for interleaved control.
 - 2. Tubes: Copper.
 - 3. Fins: Aluminum.
 - 4. Fin and Tube Joint: Mechanical bond.
 - 5. Suction and Distributor: Seamless copper tube with brazed joints.
 - 6. Source Quality Control: Test to 450 psig, and to 300 psig underwater.
- G. Condenser Fan: Propeller type, directly driven by motor.
- H. Safety Controls:
 - 1. Compressor motor and outside-coil fan motor low ambient lockout.
 - 2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.5 INDIRECT-FIRED GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
 - 1. AGA Approval: Designed and certified by and bearing label of AGA.
- B. Burners: Aluminized steel with stainless-steel inserts with a minimum thermal efficiency of 80 percent.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark with flame sensor.
 - 3. High-Altitude Kit: For Project elevations more than 2000 feet above sea level.

- C. Heat-Exchanger Drain Pan: Stainless steel.
- D. Venting: Gravity vented.
- E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
- F. Safety Controls:
 - 1. Gas Control Valve: Two stage.
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.6 OUTDOOR-AIR INTAKE AND DAMPERS

- A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.
- B. Damper Operators: Electric.
- C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.
- D. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen and finish to match cabinet.

2.7 ECONOMIZER:

- A. Provide fully modulating damper motors and controls to position outside and return air dampers so that outside air will be used to satisfy the building cooling load in the economizer cycle and minimum outside air during occupied mode.
- B. Low leakage dampers shall ride on nylon bearings.
- C. Integrated economizer control shall allow compressors to cycle for additional cooling as needed based on outdoor enthalpy.
- D. Damper actuators shall be opposing gear driven, 24 volt, fully modulating design. Plug-in control board shall consist of adjustable minimum positioner, enthalpy setpoint, and DIP switches for setting type of control logic use.
- E. Outdoor air hood with filters shall be galvanized steel with a powder coat enamel paint finish electrostatically bonded to the metal.
- F. For units 5 tons and under, provide extruded aluminum gravity relief dampers to prevent blow-back and outdoor air infiltration during off cycle.

- G. For units over 5 tons, provide Centrifugal power exhaust fan which ever is standard for size of unit.
- H. Provide rainhoods and birdscreens.

2.8 FILTERS

- A. Comply with NFPA 90A.
- B. Cleanable Filters: 2-inch- thick, cleanable metal mesh.
- C. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.
 - 1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
 - 2. Frame: Galvanized steel.

2.9 CONTROLS

- A. Provide 7 day programmable thermostat for stand alone controls.
- B. Factory-wire connection for controls' power supply.
- C. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.
- D. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
- E. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
 - 1. Timer: Seven-day electronic clock.
 - 2. Electrically interlock kitchen hood fire-extinguishing system to de-energize unit when fire-extinguishing system discharges.
- F. Unit-Mounted Status Panel:
 - 1. Cooling/Off/Heating Controls: Control operational mode.
 - 2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
 - 3. Status Lights:
 - a. Filter dirty.
 - b. Fan operating.
 - c. Cooling operating.

- d. Heating operating.
- G. Refrigeration System Controls:
 - 1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
- H. Heating Controls:
 - 1. Staged Burner Control: Two steps of control.
- I. Damper Controls - Integrate with BMS:
 - 1. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop unit at minimum 0.05-inch wg.
- J. Integral Smoke Alarm: Smoke detector installed in supply and return air. For units 2000 cfm and larger.

2.10 VIBRATION ISOLATION CURB

- A. Roof curbs shall be constructed of galvanized steel. Curbs are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.
 - 1. Unit shall be provided with a heavy duty, one piece vibration isolation curb. Each curb shall have the following features:
 - a. 1 g seismic restraint and 200 mph wind restraint.
 - b. Access ports for inspection and adjustment at each spring.
 - c. 2" deflection springs.
 - d. High frequency noise isolation.
 - e. Supply and return duct support hardware.
 - f. Galvanized steel curb with wood nailer.

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 installation of rooftop units.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

- C. Examine roof curbs and equipment supports for suitable conditions where rooftop units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install roof curb on roof structure, according to ARI Guideline B. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.
- B. Install restrained vibration isolation roof-curb rails on roof structure according to ARI Guideline B. Install and secure rooftop units on rails and coordinate roof penetrations and flashing with roof construction. Restrained isolation roof-curb rails are specified in Section "Mechanical Vibration and Seismic Controls."
- C. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
 - 1. Gas Burner Connections: Comply with requirements in Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct Connections: Duct installation requirements are specified in Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to rooftop units with flexible duct connectors. Flexible duct connectors are specified in Division 22 and 23 Section "Duct Accessories."
- D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.4 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 and perform the following:

1. Inspect for visible damage to furnace combustion chamber.
2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.
6. Verify that filters are installed.
7. Clean outside coil and inspect for construction debris.
8. Clean furnace flue and inspect for construction debris.
9. Inspect operation of power vents.
10. Purge gas line.
11. Inspect and adjust vibration isolators and seismic restraints.
12. Verify bearing lubrication.
13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Adjust fan belts to proper alignment and tension.
15. Start unit.
16. Start refrigeration system when outdoor-air temperature is within normal operating limits.
17. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
18. Operate unit for run-in period.
19. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Verify operational sequence of controls.
25. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:

- a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through outside coil or from outside coil to outdoor-air intake.
- 27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Alarms.
- C. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.
- E. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 237413

SECTION 26 0500

ELECTRICAL GENERAL PROVISIONS

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 work of this section.
- B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

1.2 DESCRIPTION OF WORK:

- A. The extent of electrical work is indicated on drawings and/or specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system. Work includes, but is not necessarily limited to, the following items.

<u>ITEM</u>	<u>SECTION</u>
1. Electrical General Provisions	26 0500
2. Mechanical and Electrical Coordination	26 0501
3. Electrical Submittals and Spare Parts	26 0502
4. Electrical Connections for Equipment	26 0507
5. Elevator Electrical Requirements	26 0510
6. Medium Voltage Cable Splices, Terminators and Connectors	26 0513
7. Conductors and Cables	26 0519
8. Flat Conductor Wiring System	26 0520
9. Grounding	26 0526
10. Supporting Devices	26 0529
11. Conduit Raceway	26 0532
12. Electrical Boxes and Fittings	26 0533
13. Raceway Systems	26 0536
14. Manholes	26 0543
15. Electrical Seismic Control	26 0548
16. Electrical Identification	26 0553
17. Protective Device Study	26 0573
18. Occupancy Sensors	26 0923
19. Lighting Control Equipment	26 0943
20. Advanced Energy & Power Metering System	26 1010
21. Medium Voltage Switches and Switchgear	26 1300
22. Transformers	26 2200
23. Switchgear and Switchboards	26 2413
24. Panelboards	26 2416
25. Motor Control Centers	26 2419
26. Busduct	26 2500
27. Service Entrance	26 2713
28. Wiring Devices	26 2726
29. Overcurrent Protective Devices	26 2815
30. Motor and Circuit Disconnects	26 2816
31. Scoreboards	26 2819

32.	Motor Starters	26 2913
33.	Variable Frequency Drives	26 2923
34.	Photovoltaic (PV) Renewable Energy System	26 3100
35.	Emergency Electrical Systems	26 3213
36.	Uninterruptible Power Supply	26 3353
37.	Power Factor Correction	26 3533
38.	Lightning Protection Systems	26 4113
39.	Demolition	26 4119
40.	Surge Protective Devices (SPD)	26 4313
41.	Interior and Exterior Building Lighting	26 5100
42.	Stage Lighting and Dimming System	26 5561
43.	Exterior Area Lighting	26 5600
44.	Telephone/Data Systems	27 1500
45.	Telephone Systems (Raceways)	27 1501
46.	Two-Way Communication	27 3244
47.	Audiovisual Systems	27 4100
48.	Television System (Raceways)	27 4123
49.	Television Systems	27 4133
50.	Sound and Intercommunication Systems	27 5123
51.	Nurse/Patient Communication Systems	27 5223
52.	Clock System	27 5313
53.	Security Systems	28 1600
54.	Security Systems (Raceways)	28 1601
55.	Access Control System	28 2205
56.	Video Arraignment Systems (Raceways)	28 2300
57.	Fire Alarm and Detection System	28 3111
58.	Fire Sprinkler Monitoring System	28 3112
- B. Use of standard industry symbols together with the special symbols, notes, and instructions indicated on the drawings describe the work, materials, apparatus and systems required as a portion of this work.
- C. Visit the site during the bidding period to determine existing conditions affecting electrical and other work. All costs arising from site conditions and/or preparation shall be included in the base bid. No additional charges will be allowed due to inadequate site inspection.

1.3 DEFINITION OF TERMS

- A. The following terms used in Divisions 26, 27 and 28 documents are defined as follows:
1. "Provide": Means furnish, install and connect, unless otherwise indicated.
 2. "Furnish": Means purchase and deliver to project site.
 3. "Install": Means to physically install the items in-place.
 4. "Connect": Means make final electrical connections for a complete operating piece of equipment.

1.4 RELATED SECTIONS:

- A. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
- B. General and Supplementary Conditions: Drawings and general provisions of contract and Division 1 of the Specifications, apply to all Division 26, 27 and 28 sections.
- C. Earthwork:
1. Provide trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, buried cable, in-grade pull boxes, manholes,

lighting pole foundations, etc. See Division 31, Sitework, and other portions of Divisions 26, 27 and 28, for material and installation requirements.

D. Concrete Work:

1. Provide forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, light pole foundations, pull box slabs, vaults, equipment pads, etc. See Division 3, Concrete for material and installation requirements.

E. Miscellaneous Metal Work:

1. Provide fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, lighting fixtures, panelboards, distribution boards, switchboards, motor controls centers, etc. See Division 5, Metals for material and installation requirements.

F. Miscellaneous Lumber and Framing Work:

1. Provide wood grounds, nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment. See Division 6, Rough Carpentry for material and installation requirements.

G. Moisture Protection:

1. Provide membrane clamps, sheet metal flashing, counter flashing, caulking and sealants as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors and ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight. See Division 7, Thermal and Moisture Protection for material and installation requirements.

H. Access panels and doors:

1. Provide in walls, ceiling, and floors for access to electrical devices and equipment. See Division 8, Doors and Windows for material and installation requirements.

I. Painting:

1. Provide surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, poles, surface metal raceways, etc. See Division 9, Finishes for material and installation requirements.

1.5 WORK FURNISHED AND INSTALLED UNDER ANOTHER SECTION REQUIRING CONNECTIONS UNDER THIS SECTION:

- A. Provide electrical service, make requisite connections and perform operational test. Items furnished and installed under other sections and connected under this section, include but are not limited to the following:

1. Electric motors.
2. Package mechanical equipment: fans, fan coil units, pumps, boilers, duplex compressors, etc.
3. Flow switches and valve monitors.
4. Motorized dampers.
5. Fire and smoke dampers
6. Duct mounted smoke detectors.
7. Irrigation controllers.
8. Door hold-open/release devices.
9. Roll down doors.
10. Electric hardware.
11. Temperature control panels.
12. Variable frequency controllers.
13. Chiller starters.
14. Water coolers.

15. Fire sprinkler alarm bells.
16. Electric heat trace cable for guttering, drain lines, etc.
17. Anti-sweat heaters, fan coils, etc. for walk-in coolers and freezers.
18. Hand dryers, hair dryers.
19. Systems/Open Office Furniture

1.6 ITEMS FURNISHED UNDER ANOTHER DIVISION, BUT INSTALLED AND CONNECTED UNDER THIS DIVISION:

- A. Items furnished under other Divisions, but turned over to Division 26 for installation and final connection include, but are not necessarily limited to, the following:
1. Wall mounted control stations for motorized roll-up doors/grills.

1.7 WORK NOT INCLUDED IN THIS DIVISION:

- A. Items of work provided under another contract include, but are not necessarily limited to, the following:
1. Telephone cables and electronic equipment.
 2. Data system cables, fittings, coverplates and electronic equipment.
 3. Control wires for irrigation control valves.
 4. Energy management/temperature control system; both line and low voltage including conductors and conduit.
 5. Television monitors and projection equipment.

1.8 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS:

- A. Before bidding, Contractor shall familiarize himself with the drawings, specifications and project site. Submit requests for clarification to Architect/Engineer in writing prior to issuance of final addendum. After signing the contract, the Contractor shall meet the intent, purpose, and function of the Contract Documents. Any costs of materials, labor and equipment arising therefrom, to make each system complete and operable, is the responsibility of the Contractor.

1.9 QUALITY ASSURANCE:

- A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies refers to the latest edition of such publications adopted and published prior to submittal of the bid proposed, unless noted otherwise herein. Such codes or standards are considered a part of this specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred as reducing the quality, requirements or extent of the Drawings and Specifications. Perform work in accordance with applicable requirements of all governing codes, rules and regulations including the following minimum standards, whether statutory or not:
1. National Electric Code (NEC).
 2. International Building Code (IBC).
 3. International Fire Code (IFC).
 4. International Mechanical Code (IMC).
- C. Standards: Comply with the following standards where applicable for equipment and materials specified under this Division.
- | | | |
|----|------|--|
| 1. | UL | Underwriters' Laboratories |
| 2. | ASTM | American Society for Testing Materials |
| 3. | CBN | Certified Ballast Manufacturers |

4. IPCEA Insulated Power Cable Engineers Association
 5. NEMA National Electrical Manufacturer's Association
 6. ANSI American National Standards Institute
 7. ETL Electrical Testing Laboratories
- D. All electrical apparatus furnished under this Section shall conform to (NEMA) standards and the NEC and bear the Underwriters' Laboratories (UL) label where such label is applicable.
- E. Comply with requirements of State and Local Ordinances. If a conflict occurs between these requirements and the Contract Documents, the most stringent requirements shall govern. The Contractor accepts this responsibility upon submitting his bid, and no extra charge will be allowed after the contract is awarded. This shall not be construed as relieving the Contractor from complying with any requirements of the Contract Documents that may be in excess of the aforementioned requirements, and not contrary to same.
- F. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Furnish a certificate of approval to the Owner's Representative from the Inspection Authority at completion of the work.
- G. Employ only qualified craftsmen with at least three years of experience. Workmanship shall be neat, have a good mechanical appearance and conform to best electrical construction practices. Provide a competent superintendent to direct the work at all times. Any person found incompetent shall be discharged from the project and replaced by satisfactory personnel.
- H. Contractor shall have a current state contracting license applicable to type of work to be performed under this contract.
- I. Required Pre-Electrical Construction Meeting with Electrical Engineer: Electrical contractor/representative will be required to attend a pre-electrical construction meeting (approximately 30-60 minutes) with engineering representative in the electrical engineer's office, or on-line remotely, prior to electrical construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to specifications, plans and site visits for both rough and finish electrical work.

1.10 CONSTRUCTION CHANGE ORDER PROPOSALS

- A. In the event that a submission of a change order is issued by the contractor, the following information will be required to be submitted by the contractor, prior to any consideration by the owner/architect.
- a. Where project manager or project engineer work is required, the labor cost shall not exceed 2% of the electrical portion of the change order.
 - b. All equipment, including conduit and wire, shall be itemized, identifying unit costs and quantities of equipment. Distributor quotes shall accompany all change order requests. The distributor quotes shall include costs for all equipment including conduit and wire. Lot pricing for equipment is not acceptable.
 - c. The general contractor shall review and confirm that the quantity and costs of materials submitted appear reasonable for the scope proposed.
 - d. Labor units shall not exceed base NECA #1 standards. No adjustment factors shall be approved.
 - e. Any research and labeling time, shall be the responsibility of the electrical contractor and shall not be included in the change order request.
 - f. Any costs associated with the purchase of tools or transportation shall be fully itemized for review by architect/owner.
 - g. Overtime rates shall only be approved where additional manpower cannot achieve the same result.
 - h. Change order form shall follow the following format:

- i. PCO number
- ii. Detailed description of work being performed
- iii. Location on project where work is performed
- iv. Chosen NECA column
- v. Identified material:
 - 1. QTY
 - 2. Unit cost
 - 3. Mark up
 - 4. Material total
- vi. Identified labor:
 - 1. QTY
 - 2. Unit cost
 - 3. Composite labor rate
 - 4. Labor total

1.11 RECORD DRAWINGS:

- A. Maintain, on a daily basis, a complete set of "Record Drawings", reflecting an accurate record of work in accordance with the following:
 - 1. Show the complete routing and location of all feeders rated 100 amps and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.)
 - 2. Show the complete routing and location of all telecommunications conduits, systems raceways, and empty raceways, 1-1/4" and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.).
 - 3. Show all changes, deviations, addendum items, change orders, job instructions, etc., that change the work from that shown on the contract documents, including wall relocations, fixtures and device changes, branch circuiting changes, etc. Where locations of boxes, raceways, equipment, etc. are adjusted in the field to fit conditions, but such new locations may not be obvious by referring to the contract document, show new locations on the record drawings.
- B. At the discretion of the Architect/Engineer, the drawings will be reviewed on a periodic basis and used as a pre-requisite for progress payments. This requirement shall not be construed as authorization for the Contractor to make changes in the layout, or work without written authorization for such changes. The "Record Drawings" for daily recording shall consist of a set of blue line prints of the Contract Drawings.
- C. Upon completion of the work, purchase a complete set of electronic drawings. Transfer all "Record" information from the blue line prints to the drawings via the current CAD program that it was written. The Architect/Engineer shall review the drawings and the Contractor shall incorporate the resulting comments into the final record drawings. The Contractor shall make two complete copies of the drawings electronically and forward this to the Engineer.
- D. Certify the "Record Drawings" for correctness by placing and signing the following certifications of the first sheet of the drawings:

"CERTIFIED CORRECT (3/8" high letters)

(Name of General Contractor)

By: _____ Date: _____

(Name of Electrical Contractor)

By: _____ Date: _____

1.12 GUARANTEE:

- A. Ensure that electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes. Without additional charge, replace any work or materials that develop defect, except from ordinary wear and tear, within one year from the date of substantial completion. Exception: Incandescent and fluorescent lamps shall be guaranteed for a period of two months from the date of substantial completion.

1.13 OTHER:

- A. Right to Hire. "Client" agrees that during the project and for a period of twenty-four (24) months following substantial completion that it will not, directly or indirectly, employ or solicit to employ BNA Personnel.

PART 2 – PRODUCTS

2.1 GENERAL:

- A. Products are specified by manufacturer name, description, and/or catalog number. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Architect/Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specifications, or should he find discrepancies therein, he shall bring this to the attention of the Architect/Engineer who will issue interpretation and/or additional instructions to Bidders before the project is bid.

2.2 MANUFACTURERS:

- A. Provide products of manufacturers specified. Manufacturers catalog numbers and descriptions establish the quality of product required. Substitutions will be considered if a duplicate written application (2-copies) is at the office of the Architect/Engineer eight (8) working days prior to the day of the bidding. The application shall include the following: 1) A statement certifying that the equipment proposed is equal to that specified; that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents; 2) The specified and submittal catalog numbers of the equipment under consideration; 3) A pictorial and specification brochure.
- B. Any conflict arising from the use of substituted equipment shall be the responsibility of the Contractor, who shall bear all costs required to make the equipment comply with the intent of the contract documents.
- C. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.
- D. No materials or apparatus may be substituted after the bid opening except where the equipment specified has been discontinued.
- E. Provide only equipment specified in the Contract Documents or approved by addendum.

2.3 SPARE PARTS:

- A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Transmit all spare parts to Owner's Representative prior to substantial completion.

PART 3 – EXECUTION

3.1 INSTALLATION:

- A. Layout electrical work in advance of construction to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary for proper installation; perform with care. Use skilled mechanics of the trades involved.

Repair damage to building and equipment at no additional cost to the contract. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting structural members shall not be permitted.

- B. Provide equipment enclosures appropriate to the environment to which they are installed. For example, provide NEMA 3R for exterior enclosures and NEMA 1 for interior enclosures unless otherwise noted.
- C. Since the drawings of floor, wall, and ceiling installation are made at small scale; outlets, devices, equipment, etc., are indicated only in their approximate location unless dimensioned. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned, and coordinate such locations with work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings, but refer to the architectural and mechanical shop drawings and project drawings for dimensions as applicable.
- D. Perform for other trades, the electrical wiring and connection for all devices, equipment or apparatus. Consult Architectural, Mechanical, and other applicable drawings, and all applicable shop drawings to avoid switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc., or from being located in chalkboards, tackboards, glass panels, etc. Relocate buried electrical devices and/or connections as directed at no additional cost.
- E. Coordinate the location of outlets, devices, connections, and equipment with the supplier of the systems furniture prior to rough-in.
- F. Where conduit, outlets or apparatus are to be encased in concrete, it must be located and secured by a journeyman or foreman present at the point of installation. Check locations of the electrical items before and after concrete and/or masonry installation and relocate displaced items.
- G. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

3.2 CLEAN:

- A. Clean up all equipment, conduit, fittings, packing cartons and other debris that is a direct result of the installation of the work of this Division.
- B. Clean fixtures, interiors and exteriors of all equipment, and raceways. Replace all filters in electrical equipment upon request for Substantial Completion.

3.3 POWER OUTAGES:

- A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the Owner. Include all costs for overtime work in bid.
- B. Submit written request at least 7 days in advance of scheduled outage and proceed with outage only after receiving authorization from the Owner's Representative.
- C. Keep all outages to an absolute minimum.

3.4 STORAGE AND PROTECTION OF MATERIALS:

- A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

3.5 EXCAVATING FOR ELECTRICAL WORK:

- A. General: Locate and protect existing utilities and other underground work in manner that will ensure that no damage or service interruption will result from excavating and

backfilling. Perform excavation in a manner that protects walls, footings, and other structural members from being disturbed or damaged in any way. Burial depths must comply with NEC Section 300-5 (or State of Utah requirement, whichever is more stringent), unless noted otherwise on drawings.

- B. Protect persons from injury at excavations, by barricades, warnings and illumination.
- C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.
- D. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or sub-bases.
- E. Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum. See other sections of specification for additional requirements for excavating.
- F. Store excavated material (temporarily) near excavation, in a manner that will not interfere with or damage excavation or other work. Do not store under trees (within drip line).
- G. Retain excavated material that complies with requirements for backfill material. Dispose of excavated material that is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site, and dispose of in lawful manner.

3.6 BACKFILL MATERIALS:

- A. For buried conduit or cable (other than below slab-on-grade, or concrete encased) - 2" thickness of well graded sand on all side of conduit or cable.
- B. For trench backfill to within 6" of final grade - soil material suitable for compacting to required densities.
- C. For top 6" of excavation - Top soil.
- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
 - 1. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.
 - 2. Paved Areas, Other than Roadways (90 percent for cohesive soils, 95 percent for cohesionless soils).
- E. Subsidence: Where subsidence is measurable or observable at electrical work excavations during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of the surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.7 CONCRETE BASES:

- A. Unless otherwise noted, provide 4" high reinforced concrete bases for all floor mounted or floor standing electrical equipment, including generators, transformers, switchgear, battery racks, motor control centers, etc. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Notwithstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 404.8.
- B. Concrete bases shall be provided under Divisions 26, 27 and 28. Coordinate size and location of all bases and furnish all required anchor bolts, sleeves, reinforcing and templates as required to obtain a proper installation.
- C. Provide and locate properly sized concrete pads for power company furnished pad mounted transformers in accordance with power company clearance requirements. Where the serving utility is Rocky Mountain Power, the electrical contractor shall conform

to the requirements of Electrical Service Requirements, Section 6.4.

3.8 ROOF PENETRATIONS:

- A. Where raceways penetrate roofing or similar structural area, provide appropriate roof jack coordinate with the roofing contractor and the Architect in order to match the vent with the roof construction. The jack shall be sized to fit tightly to raceway for weather-tight seal, and with flange extending a minimum of 9" under roofing in all sides or as required by the roof type of construction. Completely seal opening between inside diameter of roof flashing and outside diameter of penetrating raceways. Coordinate all work with work required under roofing section of specifications.

3.9 FIRE PENETRATION SEALS:

- A. Seal all penetrations for work of this section through fire rated floors, walls and ceilings to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after fire. The fire rating of the penetration seal shall be at least that of the floor, wall or ceiling that it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code. Where applicable, provide OZ Type CFSF/I and CAFSF/I fire seal fittings for conduit and cable penetrations through concrete and masonry walls, floors, slabs, and similar structures. Where applicable, provide 3M CID cast-in device for floor slabs. Where applicable, provide 3M fire barrier sealing penetration system, and/or IPC Flame Safe Fire Stop System, and/or Chase Foam fire stop system, including wall wrap, partitions, caps, and other accessories as required. All materials to comply with UL 1479 (ASTM E-814). Comply with manufacturer's instructions and recommendations for installation of sealing fittings and barrier sealing systems.

3.10 PROJECT FINALIZATION AND START-UP:

- A. Upon completion of equipment and system installation, assemble all equipment Factory Representatives and Subcontractors for system start-up.
- B. Each Representative and Subcontractor shall assist in start-up and check out their respective system and remain at the site until the total system operation is accepted by the Owner's representative.
- C. The Factory Representative and/or System Subcontractor shall give personal instruction on operating and maintenance of their equipment to the Owner's maintenance and/or operation personnel. To certify acceptance of operation and instruction by the Owner's Representative, the contractor shall prepare a written statement as follows:
 - 1. This is to certify that the Factory Representative and System Subcontractor for each of the systems listed below have performed start-up and final check out of their respective systems.
 - 2. The Owner's Representative has received complete and thorough instruction in the operation and maintenance of each system.

SYSTEM	FACTORY REPRESENTATIVE
(List systems included)	(List name and address of Factory Representative)

Owner's Representative

Contractor

- D. Send copy of acceptance to Architect/Engineer.

3.11 FINAL REVIEW:

- A. At the time of final review, the project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested, to allow review of the entire electrical system.

END OF SECTION 26 0500

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SECTION 26 0501

MECHANICAL AND ELECTRICAL COORDINATION

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 work of this section.
- B. Architectural, Structural, Vertical Transportation, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

1.2 CONTRACTOR RESPONSIBILITIES

- A. Electrical Contractor shall verify electrical service provided prior to ordering any electrical equipment serving mechanical equipment, and Electrical Contractor shall have the final responsibility for properly coordinating the electrical work, including the exact location, quantity and sizes of the electrical connection(s).
 - 1. Circuit breakers, disconnects, starters, fuses, conduit sizes, wire sizes, VFDs, etc. have been coordinated by Engineers and sized according to the mechanical systems "Basis of Design". Coordinate with Division 23 Contractor for any changes arising from substituted equipment or changes to the basis of design in any way. Coordinate all requirements of multi-motor VFD control (including fanwall units) and ensure all provisions accordingly. Prepare documentation showing changes in the electrical characteristics of each piece of equipment that has changed and submit for acceptance. All costs arising from said changes shall be the responsibility of Division 23.
- B. Obtain submittals of all mechanical equipment from Division 21 through 23 contractor(s) as they are submitted to design team.
 - 1. Notify engineer of any modifications between contract documents and submittals. It shall be the contractor's responsibility to ensure compliance with the documents.
- C. Electrical contractor shall be responsible for coordinating all their own blockouts and coordinating their space of a shared blockout.
- D. Coordinate all interfaces between Mechanical and Electrical/Communications/Security Divisions before submitting any equipment for review or beginning installation.

1.3 ABBREVIATIONS

- A. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who provides equipment and motor.
- B. TC: Temperature Controls = Division 23 09 00 Contractor who provides control.
- C. EC: Electrical Contractor = Divisions 26 through 28 Contractor who provides power/data.
- D. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Fire Alarm System.

1.4 RESPONSIBILITY SCHEDULE

- A. Responsibility: Unless otherwise indicated, all equipment, motors, and controls for Divisions 21 through 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	Furnished Under	Set In Place Under	Power Wiring Under	Control Wiring Under
AHU Interior Marine Lights (Note 8)	MC	MC	MC	MC
AHU Light Switch	EC	EC	EC	EC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Variable Frequency Drives				
-Separate	EC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
In Motor Control Centers (Note 4)	EC	EC	EC	TC
Motor Speed Controllers: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	TC	TC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC or TC	MC or TC	TC	TC
Equipment in Temperature Control Panels	TC	TC	EC	TC
Standalone Control Panels (BAS) (Note 6)	TC	TC	EC	TC
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	TC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 3)	FA	FA	EC	FA
Fire Sprinkler Alarm (Note 3)	MC	MC	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	EC	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	EC	EC	FA
Room Smoke Detectors Including Relays for Fan Control (Note 3)	MC	MC		MC
Smoke Management Controls (Note 7)	MC	MC	EC	TC
CO Sensors	FA	FA	EC	FA
Control Air Compressor	TC	TC	EC	TC
Refrigerated Air Dryer	TC	TC	EC	TC
Equipment Interlocks	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 7)	MC	MC	EC	FA
Smoke Control Dampers (for smoke management system) (Note 7)	MC	MC	EC	FA/TC
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC

B. Responsibility Schedule Notes:

1. If furnished as part of factory wired equipment furnished and set in place by MC, wiring and connections by EC.

2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set-in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor.
 3. Electrical contractor is responsible for wiring from starter to motor, unless factory wired.
 4. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
 5. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.
 - a. Division 26 and 28 shall provide all power and control wiring to fire/smoke or smoke dampers. Division 23 shall provide parallel control wiring (with 28 fire alarm having priority signal) to dampers and equipment utilized in both normal and smoke control modes. Refer to Smoke Control and Fire Alarm Drawings and the Fire Alarm Matrix.
 - b. Fire alarm system shall override automated building control system during smoke exhaust mode.
 - c. TC wiring required only when damper also serves HVAC system.
 6. FA wires from the fire alarm control panel necessary for the initiation and monitoring of the Smoke Management System Control Panel. TC wires to components and smoke control fans and dampers utilized in the control and monitoring of the Automated Building Control System.
 7. Division 26 shall provide power to junction box on the exterior of the AHU.
- C. Power Wiring by Divisions 21 through 23: The electrical power for certain equipment provided under Divisions 21 through 23 has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21 through 23 trades requiring such power. Electrical contractor shall review Division 21 through 23 drawings and coordinate with said contractors to confirm power needs.
1. Sufficient power for this purpose shall be furnished as "spare" dedicated circuit capacity in Division 26's panelboards. All wiring, conduit and electrical devices downstream of the panelboards are the responsibility of the Divisions 21 through 23 trades requiring the power.
 - a. Such equipment is hereby defined as:
 - b. Fire protection air compressors, dry-pipe control panels and valves. Required connections are included in the Division 21 work, and will be shown by that contractor's engineered system design drawings.
 - c. Pre-action system alarm and trouble initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28 fire alarm work.
 - d. Division 21 shall provide pre-action control panel and interconnection between pre-action panel and location of pre-action valve(s).
 - e. Division 28 shall provide interconnection between fire command center alarm panel (provided under Division 28) and remote communication fire alarm panel (provided under Division 28).
 - f. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or

receptacle as required by manufacturer.

- g. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in Division 23 09 00 and will be shown by that contractor's control submittal drawings.
- h. Condensate pumps. Provide power from associated unit or from nearby panelboard.
- i. BAS or Control System Gateways. Provide power from nearest panelboard and single data cable from nearest telecommunications room.

1.5 GENERAL REQUIREMENTS

A. Special Requirements:

- 1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

B. Building Management System Controls:

- 1. As required provide 120V circuit and single data cable to each building management control panel. Coordinate exact locations with controls contractor. See Specification 27-1500 / 27-1501.
- 2. Low voltage wiring from J-boxes to distributed control components, all low voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23.
- 3. Any additional power requirements shall be the responsibility of the Division 23 Contractor requiring same, and shall be provided at no additional cost to the owner.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

- A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.

- 1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
- 2. Condensate piping.
- 3. Hydronic main piping (8" and larger).
- 4. Plumbing vent piping.
- 5. Supply, return and exhaust ductwork.
- 6. Cable tray systems.
- 7. Electrical conduit 4" diameter or greater.
- 8. Hydronic branch and mains (greater than 2", but less than 8").
- 9. Domestic water piping.
- 10. Fire sprinkler mains and leaders.
- 11. Hydronic branch piping (2" and less).
- 12. Domestic hot and cold-water branches.
- 13. Electrical branch conduits.
- 14. Pneumatic control piping.
- 15. Fire sprinkler branch piping and sprinkler runouts.

- B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2").
- C. Examine the contract documents of all trades (e.g. all Divisions 21 through 23 and 26 through 28 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).
- D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.
- E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.
- F. Provide access doors for all electrical and communications equipment which require access for adjustment or servicing and which are in otherwise inaccessible locations. All access door locations must be approved by the architect prior to installation and be in as inconspicuous location as possible.
 - 1. For equipment located in "accessible locations" such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. "Normal maintenance" includes, but is not limited to: replacement of drivers, fuses, etc.

1.7 BLOCKOUT USAGE

- A. Electrical and Mechanical Contractors shall review the contract documents and advise if additional blockouts are necessary for the execution of work. Electrical and Mechanical Contractors shall coordinate and hold meetings with other contractors who will occupy the blockouts to ensure sufficient space is allocated for their scope of work. It is not acceptable to delay this meeting until conduit/piping/tray is being installed. Change orders are not acceptable due to a lack of contractor coordination prior to commencing rough in.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 26 0501

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SECTION 26 0502

ELECTRICAL SUBMITTALS, O & M MANUALS AND SPARE PARTS

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 all Division 26, 27 and 28 sections.
- B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.
- C. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 SUBMITTAL REQUIREMENTS:

A. GENERAL:

- 1. After the Contract is awarded but prior to ordering, manufacture, or installation of any equipment, prepare complete Submittals including shop drawings, product data, brochures, etc. for materials and equipment as required by each section of the specification.
- 2. Review of Submittals shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from the Contract Document's requirements. It shall be clearly understood that the noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Document's shall govern and are not waived, or superseded in any way by the review of the Shop Drawings and Brochures.
- 3. Submittals are reviewed, not approved. Comments made within submittals do not alter the contract documents in any way. The contractor is still responsible, regardless of comments (if any) made within submittals, for complying with drawings and specifications.
- 4. Notify engineer in writing if any of the comments noted in the submittals alter the contract cost. A comment within the submittal process which increases/decreases cost of product is not an authorization to the contractor under any circumstances to proceed.
- 5. Notify engineer of any modifications between contract documents and submittals. It is the responsibility of the contractor to ensure compliance.
- 6. ELECTRONIC SUBMITTAL REQUIREMENTS:
 - a. Provide submittals in Portable Document Format (PDF).
 - b. Documents must be electronically bookmarked by Division e.g. 26, 27 and 28, Specification section e.g. 26 0510 and individually for each item submitted for light fixtures, switchgear, transformer, panelboard etc. and keyword searchable using Adobe Acrobat (<http://www.adobe.com/acrobat>) or Bluebeam Revu (<http://www.bluebeam.com>) for each relevant section.
 - c. Electronically highlight all options for light fixtures, electrical equipment, etc. Manual highlighting and scanning of the documents is NOT acceptable and will NOT be reviewed.

- d. Provide only completed cutsheets for all fixture and equipment types. Blank cutsheets submitted with a schedule are NOT acceptable and will NOT be reviewed.
- e. At the time of submission, the electrical contractor shall provide a complete and comprehensive submission of all required specification sections/shop drawings at the same time. Exceptions may be given, with prior approval, for time-sensitive equipment.
- f. A maximum of one submittal per specification section is allowed. It is NOT acceptable to provide a product by product submittal. Single product by product submittals will NOT be reviewed.

B. SCHEDULING

1. GENERAL

- a. A minimum period of two weeks, exclusive of transmittal time, will be required each time Submittals are submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling submittal data.
- b. If the shop drawings are rejected twice, the contractor shall reimburse the engineering firm the sum of \$1,200.00 for the third review and any additional reviews required prior to the commencement of additional review.

C. QUALITY ASSURANCE

1. PRE-SUBMITTAL PREPARATION

- a. Prior to submission of the Shop Drawings and Project Data, review and certify that they are in compliance with the Contract Documents. Verify all dimensional information to ensure proper clearance for installation of equipment.
- b. Shop drawings requiring the use of electronic documents (floor plans, Lighting plans, fire alarm plans, etc.) shall be requested via a request for information (RFI) through the general contractor. Electronic documents will be provided to the Architect for distribution. No direct vendor requests will be accepted.
- c. Contractor is completely responsible for the content of the submittal

2. SUBMITTAL REQUIREMENTS

- a. Provide a stamp or statement on each submittal as follows:
 - i. I hereby certify that this Shop Drawing and/or Brochure has been checked prior to submittal and that it complies in all respects with the requirements of the Contract Drawings and Specifications for this Project.
(Name of Electrical Subcontractor)

Name_____.
 - Position_____Date_____
 - i. Failure to provide certification will result in submittals being rejected and returned without review.
- b. Brochures to be submitted as supplementary information shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information. Brochures submitted shall contain only information relevant to the particular equipment or materials to be furnished. The Contractor shall not submit catalogs that describe several different items in addition to those items to be used, unless all irrelevant information is marked out, or unless relevant information is

clearly marked. Brochures from each manufacturer shall be identified and submitted separately.

- c. Shop Drawings shall be done in an easily legible scale and shall contain sufficient plans, elevations, sections, and isometrics to clearly describe the equipment or apparatus, and its location. Drawings shall be prepared by an Engineer/Draftsman skilled in this type of work. Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.
- d. Observe the following rules when submitting the Shop Drawings and Brochures.
 - i. Each Shop Drawing shall indicate in the lower right hand corner, and each Brochure shall indicate on the front cover the following: Title of the sheet or brochure, name and location of the building; names of the Architect and Electrical Engineer, Contractor, Subcontractors, Manufacturer, Supplier/Vendor, etc., date of submittal, and the date of correction and revision. Unless the above information is included the submittal will be rejected and returned without being reviewed.
 - 1. Submittal Identification shall include the following:
 - a. A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted.
 - b. Original submittal numbers shall have the following format: "XXX-Y;" where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals (for example, A, B, or C being the first, second, and third resubmittals, respectively). Submittal 25B, for example, is the second resubmittal of Submittal 25.

D. POST-SUBMITTAL

- 1. Check all materials and equipment after arrival on the job site and verify compliance with the Contract Documents.

1.3 PROVIDE SUBMITTALS AS REQUESTED FOR EACH OF THE SECTIONS LISTED BELOW:

- A. 26 0519 Conductors and Cables
 - 1. (600V and Below)
 - a. Submit megohmmeter test data for circuits under 600 volts. Megger all circuits of 100 amp and greater rating.
- B. 26 0526 Grounding
 - 1. Submit the name of test agency to be used for testing specified in this section. Submit results of tests specified in this section. Also include test results in Operation and Maintenance Manuals as specified.
- C. 26 0532 Conduit Raceway
 - 1. Submit manufacturer's data on MC-PCS Power & Control/Signal Cable.
- D. 26 0533 Electrical Boxes and Fittings
 - 1. Submit manufacturer's data including specifications, installation instruction and

general recommendations for each type of floor box used on project.

- E. 26 0548 Electrical Seismic Control
1. A single submittal shall be provided for all seismic anchorage and restraints for all Division 26 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.
 2. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:
 - a. Complete engineering calculations and shop drawings for all seismic requirements for all equipment to be restrained as outlined in Section 26 0548 Specification, and as detailed on drawings.
 - b. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
 - c. Details for all seismic bracing.
 - d. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.
 - e. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
 - f. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
 - g. Include confirmation that all calculations are based on the design criteria listed in appropriate Section.
 - h. Certificate of Compliance.
 - i. Where equipment is exempt per this specification provide a written certificate of compliance for each of the systems noted with the professional seal of engineer who has reviewed the electrical system.
- F. 26 0553 Electrical Identification
1. Submit manufacturer's data on each type of electrical identification products
 - a. Submit one sample of each component of the electrical identification system as follows: Wire/cable tape marker, Tags, Engraved, plastic laminate labels, Arc-flash hazard labels
- G. 26 0573 Protective Device Study
1. Submit partial study that includes the calculated values for short circuit current availability and arc flash levels for each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, automatic transfer switch, and branch circuit panelboard. This data shall be submitted prior to, or at the same time as, submitting the entire electrical gear package. If partial study is not received prior to other submittals, the associated submittal will be rejected and not reviewed. Contractor shall utilize construction drawings to estimate approximate feeder lengths for this preliminary submittal. Submitted data shall include equipment/panel designations, feeder conductor sizes, feeder lengths, and calculated short circuit values and arc flash levels. Include the utility transformer ratings and transformer impedances used for the preparation of the short circuit calculations.
 - a. Partial study shall be submitted prior to switchboards, switchgear, panelboards, transformers, etc.
 2. Construction Period Submittal: During the construction period but prior to application of utility power to the electrical distribution system, submit an indexed copy of the complete protective device study based on actual field values. Include

the following:

- a. Introductory section with basic formulas, pertinent data, and rationale employed in the study.
 - b. One-line diagram for that portion of the system included in the study.
 - c. Calculations section showing tabulated calculations.
 - d. Results, recommendations, settings, etc.
3. Provide one revision to study based on engineering review comments for the completed study to allow for minor modifications to adjustable circuit breakers to minimize arc flash levels.

H. 26 0923 Occupancy Sensors

1. Submit manufacturer's data on occupancy sensors, control modules, wiring diagrams, instructions for installation, interconnection diagrams and any related accessories.
2. Submit scaled drawings with lighting fixtures shown and sensor equipment/devices clearly marked by manufacturer showing proper product, location, coverage pattern and orientation of each sensor.

I. 26 0943 Lighting Control Equipment

1. Submit manufacturer's data on lighting control equipment including, but not limited to published catalog data sheets, rough-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals.
2. Submit detailed drawings and documentation of lighting control components and interconnection including, but not necessarily limited to:
 - a. Electronic controllers
 - b. Control stations
 - c. Photo sensors
 - d. Occupancy sensors
 - e. Network wiring details
 - f. Input and output wiring details
 - g. Lighting control panel load schedules
 - h. Accurately scaled equipment layouts, wire/cable routing and connections to control wiring and electrical power feeders.
 - i. Submit scaled drawings/floor plans with locations of all equipment and devices clearly shown for installation purposes.

J. 26 2200 Transformers

1. Submit manufacturer's data on transformers, including certification of transformer performance efficiency, percentage regulation at 100 percent and 80 percent power factor, no-load and full load losses in watts, percent impedance at 75 degrees C, hot-spot and average temperature rise above 40 degrees C ambient, sound level in decibels, and standard published data. Before submitting product data, verify that dimensions of units to be supplied allow proper code required clearances adjacent to unit.
2. Submit dimensioned drawings of transformer installations, showing layout, mountings and supports, and spatial relationship to proximate walls and equipment.

K. 26 2413 Switchgear and Switchboards

1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2413 submittals received prior to submission of the preliminary protective device study will be REJECTED.
 2. Submit manufacturer's data on switchgear and switchboards.
 3. Submit dimensioned drawings of switchgear and switchboards showing accurately scaled basic sections including, but not necessarily limited to, auxiliary compartments, section components, and combination sections. Provide a dimensioned plan view of main electrical room showing anticipated location of equipment with dimensioned clearances to proximate equipment. Failure to submit said plan view shall not relieve contractor of responsibility to verify required clearances before release of equipment for fabrication.
- L. 26 2416 Panelboards
1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2416 submittals received prior to submission of the preliminary protective device study will be REJECTED.
 2. Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories. Provide a dimensioned plan view of main electrical room showing anticipated location of equipment with dimensioned clearances to proximate equipment. anticipated location of equipment with dimensioned clearances to proximate equipment. Failure to submit said plan view shall not relieve contractor of responsibility to verify required clearances before release of equipment for fabrication.
 3. Submit manufacturer data including specifications, installation instructions and general recommendations, for each type of panelboard required.
- M. 26 2713 Service Entrance
1. Submit manufacturer's data on service-entrance equipment and accessories.
 2. Submit dimensioned layouts of service-entrance equipment and spatial relationships to proximate equipment. Failure to submit said layouts shall not relieve contractor of responsibility to verify required clearances before release of equipment to fabrication.
 3. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2713 submittals received prior to submission of the preliminary protective device study will be REJECTED.
- N. 26 2726 Wiring Devices
1. Submit manufacturer's data on electrical wiring devices.
- O. 26 2815 Overcurrent Protective Devices
1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2815 submittals received prior to submission of the preliminary protective device study will be REJECTED.
 2. Submit manufacturer's data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.
 3. Submit layout drawings of overcurrent protective devices, with layouts of circuit breakers, including spatial relationships to proximate equipment. Failure to submit said spatial layouts does not relieve contractor of responsibility to verify all required clearances before release of equipment for fabrication.

4. Submit time-current trip curves (in log-log format) and trip setting parameter/range information (for each trip function) for all solid-state circuit breakers.
 5. Manufacturer shall also provide recommended trip settings with the shop drawing submittal (including ground fault settings) for coordination with downstream overcurrent devices. Manufacturer shall base recommendations on the AIC rating of the electrical equipment.
 6. Where the Protective Device Study specification section 260573 is included in the project, the time-current curves and recommended trip settings for all solid-state circuit breakers shall be submitted as part of the protective device study.
- P. 26 2816 Motor and Circuit Disconnects
1. Submit manufacturer's data including specifications, installation and general recommendations, for each type of motor and circuit disconnect switch required.
 2. Submit dimensioned drawings of electrical motor and circuit disconnect switches that have rating of 100 amperes and larger.
- Q. 26 2913 Motor Starters
1. Submit manufacturer's data on motor starters.
 2. Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts.
- R. 26 4313 Surge Protective Devices (SPD)
1. Submit manufacturer's data on SPD's listing all performance ratings specified or required herein.
 2. Submit dimensioned drawings of SPD's including, but not necessarily limited to, the following.
 - a. Complete data sheet.
 - b. Set of outline drawings giving complete mounting information, conduit entry and exit locations and dimensions, overall unit dimensions, weights, physical characteristics, etc.
 - c. Set of complete electrical drawings for power and control wiring.
 - d. Manufacturer's literature giving detailed information of equipment including parts numbers, model numbers and ratings.
 - e. UL 1449 suppressed voltage rating documentation.
- S. 26 5100 Interior and Exterior Building Lighting
1. Submit manufacturer's data on interior and exterior building lighting fixtures.
 2. Submit dimensioned drawings of lighting fixtures. Submit fixture shop drawings in PDF format with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with each "type" individually bookmarked, with proposed fixture catalog number and accessories clearly indicated on each sheet.
 3. When applicable submit standard color samples with the shop drawings. If standard colors are not acceptable, a color sample will be provided to the fixture manufacturer. Return of the shop drawings will be delayed until color samples are provided.
 4. Submit ballast and/or driver manufacturer cut sheets.
 5. Submit a list of all lamps used on projects.
- T. 26 5600 Exterior Area Lighting
1. Submit manufacturer's data on lighting units, including certified dimension drawings of components including, but not necessarily limited to, poles and

standards, mast arms, brackets, hardware and fixtures.

U. 27 1500 Telephone Data Systems

1. Provide proof of RCDD certification and connectivity manufacturer certification.
2. Provide submittals for all racks/cabinets; patch panels, devices, cabling, firestopping solutions, tray, non-continuous cable support devices, grounding equipment, and miscellaneous equipment to be used on project. Where multiple part numbers are listed on a datasheet/cutsheet, highlight or circle applicable part.
3. Provide submittals showing complete racking layout in plan and elevation view to scale. Coordinate exact rack layout with Owner Information Technology Representative prior to submittal.
4. Provide color samples of all available standard color faceplates to architect.
5. Provide proposed labeling scheme for approval by owner/engineer.
6. Provide catalog cutsheets of all test equipment that will be used.

V. 27 4100 Audiovisual Systems

1. The following items shall be included in the shop drawings submittal:
 - a. Project manager to provide written proof, signed and dated, that shop drawings and/or brochure has been checked for accuracy prior to submittal. Shop drawings to comply in all respects with the requirements of the contract drawings and specifications for this project.
 - b. Provide a complete bill of materials for all components, accessories and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
 - c. Submit manufacturer's data and installation details for all devices, plates, cables and similar equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
 - d. Submit dimensioned drawings and device wiring layouts for Audio, Video, Control, and power.
 - e. Submit equipment rack elevation diagrams.
 - f. Submit matrix routing and preset configuration tables, and digital signal processing configuration details.
 - g. Submit wireless microphone transmission frequencies.
 - h. Submit all manufacturer training, 3rd party and/or organization certificates for each equipment and/or systems required for the implementation of this specification.
 - i. Provide shop drawings for 27 4100 at the time of original shop drawing submission. Do not order AV equipment from the first submission. 120 days prior to the time of AV equipment installation, provide a second submission of AV equipment only. Provide current equivalent if specified model has been discontinued.
2. All touch panel layouts, page logic functions and control system functionality, shall be submitted and approved by the Owner and AV Consultant prior to installation and programming of the control systems. Contractor shall submit the following information at the following stages during the construction of the GUI.
 - a. Project manager to provide written proof, signed and dated, that shop drawings and/or brochure has been checked for accuracy prior to submittal. Shop drawings to comply in all respects with the requirements of the contract drawings and specifications for this project.

- b. Provide a complete bill of materials for all components, accessories and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
 - c. Submit manufacturer's data and installation details for all devices, plates, cables and similar equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
- W. 28 2205 Access Control System
 - 1. Submit manufacturer's data sheets including specifications, installation instructions, and general recommendation for each type of equipment specified.
 - 2. Submit dimensioned drawings and schematics for design of system. Submit actual riser diagrams of complete system and elevations of required equipment. Typical risers are not acceptable.
- X. 28 3111 Fire Alarm and Detection System
 - 1. Submit manufacturer's data on fire alarm and detection systems including, but not limited to, roughing-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals.
 - 2. Provide shop drawings showing equipment/device locations and connecting wiring of entire fire alarm and detection system. Include wiring diagrams and riser diagrams of panel. Provide dimensioned drawing of Fire Alarm Control Panel and Building Graphic. Shop drawings shall be prepared by an individual with a minimum NICET III (Fire Protection Engineering Technology/Fire Alarm Systems) certification. The individual's name and certification number shall be shown on the submittal design drawings.
 - 3. Submit a written statement to the Architect and the state and local Fire Marshal's Office that each device of the fire alarm system will be installed, inspected and tested in accordance with applicable requirements of NFPA Standard 72.
 - 4. A complete set of shop drawings indicating:
 - a. Location of all alarm-initiating and alarm-signaling devices.
 - b. Point-to-point wiring diagrams for all alarm-initiating and alarm-signaling devices.
 - c. Standby battery calculations, including voltage drop calculation.
 - 5. Wiring diagrams for:
 - a. Alarm control panels.
 - b. Auxiliary function relays and solenoids.
 - c. Remote signaling equipment.
 - 6. A complete equipment list identifying:
 - a. Type
 - b. Model
 - c. Manufacturer
 - d. Manufacturer catalog data sheets
 - e. UL Listing and/or FM approval showing compatibility of device with Fire Alarm Control Panel (FACP)
 - 7. A complete zone list identifying all:
 - a. Alarm-initiating and alarm-signaling devices.
 - b. Remote signaling and auxiliary function zones.

- c. Specific devices associated with each zone.
- 8. Submit to State and Local Fire Marshall, a complete Certificate of Compliance
- Y. 28 3112 Fire Sprinkler Monitoring System
 - 1. Submit manufacturer's data on fire sprinkler monitoring systems including, but not limited to, roughing-in diagrams and instructions for installation, operation and maintenance, suitable for inclusion in maintenance manuals. Also include standard or typical riser and complete wiring diagrams for panel and system.
 - 2. Provide shop drawings showing equipment/device locations and connecting wiring of system. Include wiring diagrams and riser diagrams.
 - 3. Submit a written statement to the Architect, and the state and local Fire Marshal's Office that each device of the system has been installed, inspected and tested in accordance with applicable requirements of NFPA Standard 72. This statement shall be submitted at the time of completion of the system installation.

1.4 OPERATION & MAINTENANCE MANUALS

- A. Provide operating instruction and maintenance data books for all equipment and materials furnished under this Division.
- B. Submit four copies of operating and maintenance data books for review at least four weeks before final review of the project. Assemble all data in a completely indexed volume or volumes and identify the size, model, and features indicated for each item. The binder (sized to the material) shall be a 2" slide lock unit (Wilson-Jones WLJ36544B). The cover shall be engraved with the job title in 1/2" high letters and the name and address of the Contractor in 1/4" high letters. Provide the same information in 1/8" letters on the spine.
- C. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Show serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, etc. Each unit shall have its own individual sheet. (Example: If two items of equipment A and D appear on the same sheet, an individual sheet shall be provided for each unit specified).
- D. Include the following information where applicable.
 - 1. Identifying name and mark number.
 - 2. Certified outline Drawings and Shop Drawings.
 - 3. Parts lists.
 - 4. Performance curves and data.
 - 5. Wiring diagrams.
 - 6. Light fixture schedule with the lamps and ballast data used on the project for all fixtures
 - 7. Manufacturer's recommended operating and maintenance instructions.
 - 8. Vendor's name and address for each item.
- E. The engineer shall review the manuals and when approved, will forward the manuals on to the architect. If the manuals are rejected twice, the contractor shall reimburse the engineer the sum of \$1,200.00 for each review afterwards.
- F. Provide Operation and Maintenance Manual information for each section listed below in addition to the general requirements listed above.
 - 1. 26 0526 Grounding
 - a. Test Results of measured resistance values
 - 2. 26 0548 Electrical Seismic Control
 - a. Certificate of Compliance from Final Inspection
 - 3. 26 0923 Occupancy Sensors
 - a. Record Drawings

- i. A complete set of 'as-builts' drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.
 - ii. Provide a CD to the owner containing the information specified below. The CD shall include all information required to allow the Owner to change the schedules themselves. The CD shall contain a minimum of following:
 - 1. CAD drawing files of 'as-built' lighting control components and point to point connections.
 - 2. General configuration programming.
 - 3. Job specific configuration programming to include schedule.
 - 4. Tutorial file on complete programming of lighting control system.
- 4. 26 0943 Lighting Control Equipment
 - a. Record Drawings
 - i. A complete set of 'as-builts' drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.
 - ii. Provide a CD to the owner containing the information specified below. The CD shall include all information required to allow the Owner to change the schedules themselves. The CD shall contain a minimum of following:
 - 1. CAD drawing files of 'as-built' lighting control components and point to point connections.
 - 2. General configuration programming.
 - 3. Job specific configuration programming to include schedule.
 - 4. Tutorial file on complete programming of lighting control system.
- 5. 26 2913 Motor Starters
 - a. After installation is complete, including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage, amperage, service factor, and thermal heater size installed for each motor.
- 6. 27 1500 Telephone/Data System
 - a. Test Results as outlined in Section 27 1500
 - b. Manual shall include all service, installation, programming and warranty, including test results for each cable.
 - c. Provide laminated plans (minimum size 11 x 17) of all telecommunications record drawings (including riser diagrams) in each and every EF, ER and TR.
 - d. Record Drawings

- i. The Owner shall provide electronic (DWG) format of telephone/data system drawings that as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.
 - ii. Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) formats showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment within 30 working days of completion. Drawings are to include all labeling information used in denoting equipment used in the installation. Labeling, icons, and drawing conventions used shall be consistent throughout all documentation provided.
- 7. 27 4100 Audiovisual System
 - a. Manual Requirements
 - i. Operating and maintenance manuals shall be submitted prior to testing of system. Total of two (2) manuals, shall be delivered to the Company. Manuals shall include all model numbers, service, installation, and programming information.
 - ii. Include all the following information:
 - 1. Warranty
 - 2. Network settings
 - 3. Riser diagrams from Shop drawings
 - 4. Training videos
 - 5. USB Flash drive with programing source code and software editing programs
 - b. Record Drawings
 - i. The Owner shall provide electronic (DWG) format of AV System drawings that as-built construction information can be added to. These documents will be modified by the AV contractor to denote as-built information as defined above and returned to the Owner.
 - ii. Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) formats showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment. Drawings are to include all labeling information used in denoting equipment used in the installation. Labeling, icons, and drawing conventions used shall be consistent throughout all documentation provided.
- 8. 28 2300 IP Video Surveillance System
 - a. Record Drawings
 - i. A complete set of CAD "AS-BUILT" Drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.

- ii. A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD security drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various by the use of different colors (minimum of five colors).
- iii. The disk containing the files shall be supplied to the owner. These disks shall include all information required to allow the district to change the security program themselves. These computer disks shall contain a minimum of the following:
 - 1. CAD drawing files of building security map.
 - 2. CAD drawing files of AS BUILT security components and point to point connections.
 - 3. General configuration programming.
 - 4. Job specific configuration programming.
 - 5. Tutorial file on complete programming of security system.

b. Record Drawings

- i. A complete set of CAD "AS-BUILT" Drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.
- ii. A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD security drawing. Edges of the sign shall be colored to match the building interior.
- iii. The disk containing the files shall be supplied to the owner. These disks shall include all information required to allow the district to change the security program themselves. These computer disks shall contain a minimum of the following:
 - 1. CAD drawing files of building security map.
 - 2. CAD drawing files of AS BUILT security components and point to point connections.
 - 3. General configuration programming.
 - 4. Job specific configuration programming.
 - 5. Tutorial file on complete programming of security system.

- a. Manual Requirements
 - i. Operating and maintenance manuals shall be submitted prior to testing of the system. Manuals shall include all service, installation, and programming information.
- b. Record Drawings
 - i. A complete set of CAD "as-built" drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system. Vendor shall not request drawings from the Engineer. Vendor shall request current architectural drawings from the Architect and include all cost with bid.
 - ii. A building map shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building fire alarm map adjacent to the fire alarm panel and all remote operating panels. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD fire alarm drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various devices and wiring by the use of different colors (minimum of five colors).
 - iii. Provide a CD to the Owner containing the information specified below. The CD shall include all information required to allow the Owner to change the fire alarm program themselves. The CD shall contain a minimum of the following:
 - 1. CAD drawing files of building fire alarm map.
 - 2. CAD drawing files of as-built fire alarm components and point to point connections.
 - 3. General configuration programming.
 - 4. Job specific configuration programming.
 - 5. Tutorial file on complete programming of fire alarm system

1.5 SPARE PARTS:

- A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Stock of all spare items shall be delivered as directed to Owner's storage space prior to substantial completion. All components shall be labeled to match construction document nomenclature.

Section	Section Name	Description	Qty. Required	Qty. Received	Fulfilled?
26 0532	Conduit Raceway	Provide 1000 feet of ¾" conduit with 3 #12 conductors and 1000 feet of ¾" conduit with 3 #10 conductors. Provide all supports, fittings, boxes, terminations, etc. as required for installation. Install only as directed by engineer. Credit back all unused material and labor to Owner.	Per description		
26 0923	Occupancy Sensors	Spare sensors for each type used on project.	5 per type		
26 1300	Medium Voltage Switches & Switchgear	Spare fuses equal to 10% of the total quantity of each size and type used, but no less than three spare fuses of each type and size used.	Per description		

26 2200	Transformers	Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every five installed units, but not less than three units of each (including ELSP fuses when specified).	Per description		
26 2413	Switchgear and Switchboards	Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than 3 units of each.	Per description		
26 2713	Service Entrance	Maintenance Stock Fuses: for types and ratings required, furnish additional fuses, amounting to one for every 2 installed units, but not less than one unit of each.	Per description		
26 2815	Overcurrent Protective Devices	For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than two units of each size and type, unless specified otherwise in another section of these specifications.	Per description		
26 2816	Motor and Circuit Disconnects	Spare fuses amounting to one spare fuse for each 10 installed but not less than three of any one type and size.	Per description		
26 2913	Motor Starters	Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed, but not less than 5 units of each, for both power and control circuit fuses.	Per description		
26 5100	Interior and Exterior Building Lighting	Spare diffusers (acrylic and/or glass only) for each fixture type. One set shall be provided per fixture type and one additional per every (10) fixtures of each type; quantity shall not exceed (10) spares for any single fixture type.	Per description		
		Furnish stock of replacement LED drivers for each type and size provided on the project. A minimum quantity of 15% but no less than two (2) shall be furnished.	Per description		
		Furnish stock of replacement serviceable LED components (ie: boards, drivers, etc.) for each type and size provided on the project. A minimum quantity of 15% but no less than two (2) shall be furnished.	Per description		
		Furnish stock of replacement LED light fixtures for each type and size provided on the project. A minimum quantity of two (2) fixtures shall be furnished. For linear pendant fixtures, provide three (3) four-foot modules.	Per description		
		Provide a complete spare parts list in lighting shop drawing review			
26 5600	Exterior Area Lighting	Provide (3) spare fuses for each type and size used.	Per description		
28 3111	Fire Alarm and Detection	Smoke detectors with base	10		
		Thermal detectors with base	10		
		Strobe/horns	10		
		Manual pull stations with addressable modules	5		
		Duct smoke detectors	4		
		20 feet of conduit with wiring (completely installed and wired) for each spare device	Per description		

END OF SECTION 26 0502

SECTION 260507

ELECTRICAL CONNECTIONS FOR EQUIPMENT

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-23 section making reference to electrical connections.

1.2 DESCRIPTION OF WORK:

- A. Extent of electrical connection for equipment includes final electrical connection of all equipment having electrical requirements. Make final connections for all owner furnished equipment. See other applicable portions of specification for building temperature control wiring requirements.
- B. Refer to Division-23 sections for motor starters and controls furnished integrally with equipment; not work of this section.
- C. Refer to Division-23 section for control system wiring; not work of this section.
- D. Refer to sections of other Divisions for specific individual equipment power requirements.

1.3 QUALITY ASSURANCE:

- A. NEC COMPLIANCE: Comply with applicable portions of NEC as to type products used and installation of electrical power connections.
- B. UL LABELS: Provide electrical connection products and materials that have been UL-listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections as required. Crimp on or slip-on type splicing materials (insulation displacement type) designed to be used without wire stripping are not acceptable. See Section 26 0532, Conduit Raceways; Section 26 2726 Wiring Devices; and Section 26 0519 Conductors and Cables for additional requirements. Provide final connections for equipment consistent with the following:
 - 1. Permanently installed fixed equipment - flexible seal-tite conduit from branch circuit terminal equipment, or raceway; to equipment, control cabinet, terminal junction box or wiring terminals. Totally enclose all wiring in raceway.
 - 2. Movable and/or portable equipment - wiring device, cord cap, and multi-conductor cord suitable for the equipment and in accordance with NEC requirements (Article 400).
 - 3. Other methods as required by the National Electrical Code and/or as required by special equipment or field conditions.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.
- C. Coordinate installation of electrical connections for equipment with equipment installation work.
- D. Verify all electrical loads (voltage, phase, horse power, full load amperes, number and point of connections, minimum circuit ampacity, etc.) for equipment furnished under other Divisions of this specification, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report any variances from electrical characteristics noted on the electrical drawings to Architect before proceeding with rough-work. In summary it is not in the Electrical Engineers scope to review the shop drawings from other trades/divisions.
- E. Obtain and review the equipment shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.
- F. Refer to basic materials and methods Section 26 0553 Electrical Identification, Conductors, for identification of electrical power supply conductor terminations.

END OF SECTION 26 0507

SECTION 26 0519

CONDUCTORS AND CABLES (600V AND BELOW)

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to conductors and cables specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of electrical conductor and electrical cable work is indicated by drawings and schedules.
- B. Types of conductors and cables in this section include the following:
 - 1. Copper Conductors (600V)
 - 2. Aluminum Conductor (600V)
- C. Applications for conductors and cables required for project include:
 - 1. Power Distribution
 - 2. Feeders
 - 3. Branch Circuits

1.3 RECORDS SUBMITTAL: Refer to Section 26 0502 for requirements.

1.4 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical conductors and cable. Comply with UL standards and provide electrical conductors and cables that have been UL-listed and labeled.
- B. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of conductors and cable.
- C. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of conductors and cable.

1.5 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 COPPER AND ALUMINUM CONDUCTORS (600V):

- A. Provide factory-fabricated conductors of sizes, ratings, materials, and types indicated for each service. Where not indicated provide proper selection to comply with project's installation requirements and NEC standards. Provide conductors in accordance with the following:
 - 1. Service Entrance Conductors – Aluminum conductor; see drawings for insulation type.
 - 2. Distribution and Panelboard Feeders; and Other Conductors, #2 AWG and Larger – Aluminum conductor; see drawings for insulation type.
 - 3. Branch Circuit Conductors and All Conductors #3 AWG and Smaller - Copper conductor, with THHN/THWN insulation. Size all conductors in accordance with

NEC; minimum size to be #12 AWG. Provide solid conductors for #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.

4. [Aluminum Conductors. Where aluminum conductors are specified for use, provide compact stranded Aluminum Association 8000- series alloy conductor material.
 - a. [Stabiloy - Alcan Cable](#)
 - b. [Triple E - Southwire](#)
- B. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination. Provide one size larger neutral conductor than the branch circuit conductor for all multi-wire branch circuits.
- C. Provide neutral and ground wire as specified elsewhere in documents.
- D. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install electric conductors and cables as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.
- B. Coordinate installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. Cables may be pulled by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device shall be made through approved swivel connection. Nonmetallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop that pull wires can be attached; remove insulation from conductors before forming the loop. Larger sizes of cable may be pulled by using basket weave pulling grip, provided the pulling force does not exceed limits recommended by manufacturer; if pulling more than one cable, bind them together with friction tape before applying the grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.
- D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.
- E. Pull in cable from the end having the sharpest bend; i.e. bend shall be closest to reel. Keep pulling tension to minimum by liberal use of lubricant, and turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one in pullhole during this operation.
- F. For training of cables, minimum bend radius to inner surface of cable shall be 12 times cable diameter.
- G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.
- H. Use only wire and cable pulling compound recommended by the specific cable manufacturer, and that is listed by UL.

- I. Seal all cable ends unless splicing is to be done immediately. Conduit bodies shall not contain splices.
- J. Support all cables in pullholes, concrete trenches, and similar locations by cable racks and secure to rack insulators with nylon cord or self-locking nylon cable ties. Place each cable on separate insulator. In manholes, pullholes, concrete trenches, and similar locations, wrap strips of fire-proofing tape (approx. 1/16 inch thick by 3 inches wide) tightly around each cable spirally in half-lapped wrapping or in two butt-joined wrappings with the second wrapping covering the joints in the first. Apply tape with the coated side toward the cable, and extend tape one inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure sensitive glass cloth tape. Provide fireproofing tape of a flexible, conformable fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick weighing not less than 2.5 pounds per square yard. Provide tape that is noncorrosive to cable sheath, self-extinguishing, and that will not support combustion. Construct tape of materials that do not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.
- K. Follow manufacturer's instructions for splicing and cable terminations.

3.2 AFTER INSTALLATION TEST FOR CABLE 600 VOLTS AND BELOW:

- A. Prior to energization, test cable and wire for continuity of circuitry, and for short circuits, Megger all circuits of 100 amp and greater rating. Correct malfunctions. Record all test data and provide written test report.
- B. Subsequent to wire and cable connections, energize circuitry and demonstrate functioning in accordance with requirements.

3.3 IDENTIFICATION OF FEEDERS: Refer to Section 26 0553 for requirements.

END OF SECTION 26 0519

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SECTION 26 0526

GROUNDING

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 work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Provide grounding as specified herein, and as indicated on drawings.
- B. Provide grounding and bonding of all electrical and communication apparatus, machinery, appliances, building components, and items required by the NEC to provide a permanent, continuous, low impedance, grounding system.
- C. Unless otherwise indicated, ground the complete electrical installation including the system neutral, metallic conduits and raceways, boxes, fittings, devices, cabinets, and equipment in accordance with all code requirements.
- D. Ground each separately derived system, as described in NEC Section 250-30, unless otherwise indicated.
- E. Types of grounding in this section include the following:
 - 1. Underground Metal Water Piping
 - 2. Metal Building Frames
 - 3. Grounding Electrodes
 - 4. Grounding Rods
 - 5. Reference Ground Buses
 - 6. Separately Derived Systems
 - 7. Service Equipment
 - 8. Enclosures
 - 9. Systems
 - 10. Equipment
 - 11. Other items indicated on drawings
- F. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to electrical grounding and ground fault protection systems. Comply with applicable ANSI and IEEE requirements. Provide products that have been UL listed and labeled.
- B. Resistance from the service entrance ground bus, through the grounding electrode to earth, shall not exceed 5 ohms.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. GENERAL: Except as otherwise indicated, provide each electrical grounding system as specified herein, and as shown on drawings, including but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.
- B. ELECTRICAL GROUNDING CONDUCTORS: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC. Provide with green insulation.
- C. GROUND RODS: Steel with copper welded exterior, 3/4" dia. x 10' long. Weaver or Cadweld.
- D. GROUND WELL BOXES FOR GROUND RODS: Precast concrete box 9-1/2" W. x 16" L. X 18" D. with light duty concrete cover for non-traffic areas or rated steel plate for traffic areas. Provide covers with lifting holes. Engrave cover with "GROUND ROD".
- E. CONCRETE ENCASED GROUNDING ELECTRODE (UFER GROUND): #2/0 AWG bare copper conductor.
- F. INSULATED GROUNDING BUSHINGS: Plated malleable iron body with 150-degree Centigrade molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners, OZ-Gedney BLG, or Thomas & Betts #TIGB series.
- G. CONNECTIONS TO PIPE: For cable to pipe, OZ-Gedney G-100B series or Thomas & Betts #390X series, or Burndy type GAR.
- H. CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES: For splicing and/or connecting conductors, use exothermic welds or high-pressure compression type connectors. Provide exothermic weld kits manufactured by Cadweld or Thermoweld. If high compression type connectors are used for cable-to-cable, or cable-to-steel, or cable-to-ground rod connections, provide Thomas & Betts #53000 series, or Burndy Hyground series.
- I. BONDING JUMPERS: OZ-Gedney Type BJ, or Thomas & Betts #3840 series, or Burndy type GG and type B braid.
- J. MAIN BUILDING REFERENCE GROUND BUS: Provide one 18" L. X 2" H X 1/4" thick copper bus bar (or size noted on drawings). Mount on walls in locations shown, on insulating stand offs, 18" AFF. Furnish complete with lugs for connecting grounding system cables. All holes shall be drilled and tapped for single hole lugs. Provide 6 spare lugs and 6 lug spaces.
- K. INTERSYSTEM BONDING TERMINAL: Provide one 12" L. x 2" H x 1/4" thick copper bus bar. Mount on wall adjacent to Main Electrical Service Equipment on insulating standoffs, 18" A.F.F. Furnish complete with lugs for connecting systems grounding cables. All holes shall be drilled for 2-hole compression lugs. Provide 6 spare lugs. Connect to equipment grounding bus in Main Electrical Service Equipment with No. 4 AWG copper conductor.

PART 3 - EXECUTION

3.1 INSTALLATION OF GROUNDING SYSTEMS:

- A. Install electrical grounding systems in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding devices comply with requirements.

- B. Install clamp-on connectors only on thoroughly cleaned and metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- C. Provide grounding for the entire raceway, enclosure, equipment and device system in accordance with NEC. All non-metallic raceways shall include copper grounding conductor sized in accordance with NEC. Include copper grounding conductor in all raceway installed in suspended slabs.
- D. Provide service entrance grounding by means of ground rods (quantity of two, driven exterior to building), by means of bonding to water main, and by means of bonding to building structural steel. In addition, provide a grounding electrode for not less than 30 lineal feet in concrete footing or foundation that is in direct contact with earth. Size electrode in accordance with NEC, but in no case, smaller than No. 4 AWG bare copper. Support electrode so as to be below finished grade near the bottom of the trench, and approximately three inches from the bottom or sides of the concrete. Locate a point of connection for inspection.
- E. Provide grounding conductors for dimming systems in accordance with manufacturer's requirement.

3.2 GROUNDING ELECTRODES:

- A. Concrete Encased Grounding Electrode (UFER Ground): Provide a #2/0 AWG minimum bare copper conductor encased along the bottom of concrete foundation or footings that are in direct contact with the earth and where there is no impervious water-proofing membrane between the footing and the soil. Extend electrode through a horizontal length of 30 feet minimum and encase with not less than 2 nor more than 5 inches of concrete separating it from surrounding soils. At point of emergence from concrete, run electrode through a protective non-metallic sleeve and extend to the main building reference ground bus.
- B. Separately Derived Electrical System Grounding Electrode: Ground each separately derived system per requirements in NEC Section 250-26 unless indicated otherwise.
- C. GROUNDING ELECTRODE CONDUCTOR: Provide grounding electrode conductor sized per NEC table 250-94 or as indicated.
- D. POWER SYSTEM GROUNDING: Connect the following items using NEC sized copper grounding conductors to lugs on the Main Building Ground Bus.
 - 1. Grounding electrode conductor from concrete encased electrode, from ground rods, and from service entrance ground bus.
 - 2. Conductor from main incoming cold water piping system.
 - 3. Conductor from building structural steel.
 - 4. Ground for separately derived systems.
- E. Run main grounding conductors exposed or in metallic conduit if protection or concealment is required.
- F. EQUIPMENT BONDING/GROUNDING: Provide a NEC sized conductor, whether indicated or not on the drawings, in raceways as follows:
 - 1. Non-metallic conduits and ducts.
 - 2. Distribution feeders.
 - 3. Motor and equipment branch circuits.
 - 4. Device and lighting branch circuits.
 - 5. Provide grounding bushings and bonding jumpers for all conduit terminating in reducing washers, concentric, eccentric or oversized knockouts at panelboards, cabinets and gutters.
- G. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold

water piping system.

- H. Provide bonding wire in all flexible conduit.

3.3 TESTING:

- A. Obtain and record ground resistance measurements both from service entrance ground bus to the ground electrode and from the ground electrode to earth. Install additional bonding and grounding electrodes as required to comply with resistance limits specified under this Section.
- B. Include typewritten records of measured resistance values in the Operation and Maintenance Manual.
- C. Use independent testing agency for all testing.
- D. Use test equipment expressly designed for the purpose intended. Submit name of testing agency for review and approval, in writing, to the Engineer prior to the performance of any testing.

END OF SECTION 26 0526

SECTION 26 0529

SUPPORTING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification section, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to supports, anchors, sleeves, and seals, specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of supports, anchors, and sleeves is indicated by drawings and schedules and/or specified in other Division-26 sections. See Section 260532, Raceways, for additional requirements.
- B. Work of this section includes supports, anchors, sleeves and seals required for a complete raceway support system, including but not limited to: clevis hangers, riser clamps, C-clamps, beam clamps, one and two hole conduit straps, offset conduit clamps, expansion anchors, toggle bolts, threaded rods, U-channel strut systems, threaded rods and all associated accessories.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical supporting devices. Comply with applicable requirements of ANSI/NEMA Std. Pub No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies". Provide electrical components that are UL-listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES:

- A. GENERAL:
 - 1. Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. See drawings for additional requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES:

- 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, NEC and ANSI/NEMA 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 piping properly from building structures. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. For pre-and post tensioned construction, use pre-set inserts for support of all electrical work. Do not use toggle bolts, moly bolts, wood plugs or screws in sheetrock or plaster as support for any equipment or

raceway.

D. RACEWAYS:

1. Support raceways that are rigidly attached to structure at intervals not to exceed 8 feet on center, minimum of two straps per 10 foot length of raceway, and within 12" of each junction box, coupling, outlet or fitting. Support raceway at each 90° degree bend. Support raceway (as it is installed) in accordance with the following:

<u>NUMBER OF RUNS</u>	<u>3/4" TO 1-1/4" Ø</u>	<u>1-1/2" & LARGER Ø</u>
1	Full straps, clamps or hangers.	Hanger
2	Full straps, clamps or hangers.	Mounting Channel
3 or more	Mounting Channel	Mounting Channel

2. Support suspended raceways on trapeze hanger systems; or individually by means of threaded rod and straps, clamps, or hangers suitable for the application. Do not use independent support wires as a portion of any raceway support system; do not support raceway from ceiling support wires.

E. FLOOR MOUNTED EQUIPMENT:

1. Provide rigid attachment of all floor mounted equipment to the floor slab or structural system. Provide 5/8" bolts or expansion anchors at each 90 degree corner and at intervals not to exceed 48" on center along entire perimeter of the equipment. Provide rigid attachment for all floor mounted switchboards, panelboards, power and control equipment, motor control centers, dimmer cabinets, transformers (provide neoprene vibrations isolators at anchor points), oil switches, battery packs and racks, and similar equipment furnished under Division 26, 27 and 28.

F. WIREWAYS, BUS DUCTS AND CABLE TRAYS:

1. Provide vertical and lateral support systems for all wireways, busway, and cable trays that are supported from overhead structure. See Sections 260536 and 262500 for additional requirements.

END OF SECTION 26 0529

SECTION 26 0532

CONDUIT RACEWAY

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to electrical raceways and specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of raceways is indicated by drawings and schedules.
- B. Types of raceways in this section include the following:
 - 1. Electrical Metallic Tubing
 - 2. Flexible Metal Conduit
 - 3. Intermediate Metal Conduit
 - 4. Liquid-tight Flexible Metal Conduit
 - 5. Rigid Metal Conduit
 - 6. Rigid Non-metallic Conduit

1.3 QUALITY ASSURANCE:

- A. MANUFACTURERS: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. STANDARDS: Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components that have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.
- C. SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 METAL CONDUIT AND TUBING:

- A. GENERAL:
 - 1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".
- B. RIGID METAL CONDUIT (RMC): FS WW-C-0581 and ANSI C80.1.
- C. INTERMEDIATE STEEL CONDUIT (IMC): FS WW-C-581.
- D. PVC EXTERNALLY COATED RIGID STEEL CONDUIT: ANSI C80.1 and NEMA Std. Pub. No. RN 1.
- E. ALUMINUM CONDUIT: Not acceptable.
- F. MC CABLE: Not acceptable.
- G. MC-PCS CABLE

1. The use of MC-PCS cable is acceptable for light fixture whips utilizing 0-10v control schemes, not longer than 72" in length, located above removable grid ceilings. All MC cable shall be provided with anti-short fittings.
 - a. Acceptable Manufacturers
 - i. AFC – MC Luminary Cable
 - ii. Encore – MC-LED Lighting Cable
 - iii. Southwire – MC-PCS Duo

H. RIGID AND INTERMEDIATE STEEL CONDUIT FITTINGS:

1. Provide fully threaded malleable steel couplings; raintight and concrete tight where required by application. Provide double locknuts and metal bushings at all conduit terminations. Install OZ Type B bushings on conduits 1-1/4" and larger.

I. ELECTRICAL METALLIC TUBING (EMT): FS WW-C-563 and ANSI C80.3.

J. EMT FITTINGS:

1. Provide insulated throat nylon bushings with non-indenter type malleable steel fittings at all conduit terminations. Install OZ Type B bushings on conduits 1" larger. Cast or indenter type fittings are not acceptable.

K. FLEXIBLE METAL CONDUIT: FS WW-C-566, of the following type;

1. Zinc-coated steel.

L. FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 1, and Style A.

M. LIQUID TIGHT FLEXIBLE METAL CONDUIT:

1. Provide 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).

N. LIQUID-TIGHT FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 3, Style G.

O. EXPANSION FITTINGS: OZ Type AX, or equivalent to suit application.

2.2 NON-METALLIC CONDUIT AND DUCTS:

A. GENERAL:

1. Provide non-metallic conduit, ducts and fittings of types, sizes and weights as indicated; with minimum trade size of 3/4".

B. UNDERGROUND PVC PLASTIC UTILITIES DUCT:

1. Minimum requirements shall be schedule 40 for encased burial in concrete and for Type II for direct burial.

C. PVC AND ABS PLASTIC UTILITIES DUCT FITTINGS:

D. ANSI/NEMA TC 9, match to duct type and material.

E. HDPE CONDUIT: Not acceptable.

2.3 CONDUIT; TUBING; AND DUCT ACCESSORIES:

- A. Provide conduit, tubing and duct accessories of types and sizes, and materials, complying with manufacturer's published product information, that mate and match conduit and tubing. Provide manufactured spacers in all duct bank runs.

2.4 SEALING BUSHINGS:

- A. Provide OZ Type FSK, WSK, or CSMI as required by application. Provide OZ type CSB

internal sealing bushings.

2.5 CABLE SUPPORTS:

- A. Provide OZ cable supports for vertical risers, type as required by application.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS:

- A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and in accordance with the following:
 - 1. SERVICE ENTRANCE CONDUCTORS, AND CONDUCTORS OVER 600 VOLTS:
 - a. Install in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct, individually encased in concrete. See duct banks.
 - 2. FEEDERS UNDER 600 VOLTS:
 - a. Install feeders to panels and motor control centers and individual equipment feeders rated 100 amps and greater, in rigid metal conduit (RMC), or intermediate metal conduit (IMC), except where buried below grade, install in non-metallic conduit or duct. Encase feeders 1-1/4" and larger, individually in concrete where installed below grade. See duct banks.
 - 3. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS:
 - a. Install in electric metallic tubing (EMT). Below concrete slab-on-grade or in earth fill, install in non-metallic plastic duct. In areas exposed to weather, moisture, or physical damage, install in RMC or IMC. Conduit not allowed in suspended slabs. Encase non-metallic duct 40-amp circuits, 1-1/4" and larger in concrete. See duct banks.
- B. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.
- C. Install raceway in accordance with the following:
 - 1. Provide a minimum of 12" clearance measured from outside of insulation from flues, steam and hot water piping, etc. Avoid installing raceways in immediate vicinity of boilers and similar heat emitting equipment. Conceal raceways in finished walls, ceilings and floor (other than slab-on-grade), except in mechanical, electrical and/or communication rooms, conceal all conduit and connections to motors, equipment, and surface mounted cabinets unless exposed work is indicated on the drawings. Run concealed conduits in as direct a line as possible with gradual bends. Where conduit is exposed in mechanical spaces, etc., install parallel with or at right angles to building or room structural lines. Do not install lighting raceway until piping and duct work locations have been determined in order to avoid fixtures being obstructed by overhead equipment.
 - 2. Where cutting raceway is necessary, remove all inside and outside burrs; make cuts smooth and square with raceway. Paint all field threads (or portions of raceway where corrosion protection has been damaged) with primer and enamel finish coat to match adjacent raceway surface.
 - 3. Provide a minimum of 1 1/2" from nearest surface of the roof decking to raceway.

4. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination. Provide one size larger neutral conductor than the branch circuit conductor for all multi-wire branch circuits.
 5. Provide neutral and ground wire as specified elsewhere in documents.
 6. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.
- D. Comply with NEC for requirements for installation of pull boxes in long runs.
 - E. Cap open ends of conduits and protect other raceways as required against accumulation of dirt and debris. Pull a mandrel and swab through all conduit before installing conductors. Install a 200 lb. nylon pull cord in each empty conduit run.
 - F. Replace all crushed, wrinkled or deformed raceway before installing conductors.
 - G. Do not use flame type devices as a heat application to bend PVC conduit. Use a heating device that supplies uniform heat over the entire area without scorching the conduit.
 - H. Provide rigid metal conduit (RMC) for all bends greater than 22 degrees in buried conduit. Provide protective coating for RMC bend as specified herein.
 - I. Where raceways penetrate building, area ways, manholes or vault walls and floors below grade, install rigid metal conduit (RMC) for a minimum distance of 10 feet on the exterior side of the floor or wall measured from interior face. Provide OZ, Type FSK, WSK or CSMI sealing bushings (with external membrane clamps as applicable) for all conduit penetrations entering walls or slabs below grade. Provide segmented type CSB internal sealing bushings in all raceways penetrating building walls and slabs below grade, and in all above grade raceway penetrations susceptible to moisture migration into building through raceway.
 - J. Install liquid-tight flexible conduit for connection of motors, transformers, and other electrical equipment where subject to movement and vibration.
 - K. Install spare 3/4" conduits (capped) from each branch panelboard into the ceiling and floor space. Run five into the ceiling space and five into the floor space. Where the floor is not accessible run six conduits into the ceiling space. Run conduits the required distance necessary to reach accessible ceiling space.
 - L. Provide OZ expansion fittings on all conduits crossing building expansion joints, both in slab and suspended.
 - M. Provide OZ cable supports in all vertical risers in accordance with NEC 300-19; type as required by application.
 - N. Complete installation of electrical raceways before starting installation of cables/conductors within raceways.
 - O. Raceway installation below grade:
 1. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.
 2. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.
 - P. Raceway installation below slab-on-grade, or below grade:
 1. For slab-on-grade construction, install runs of rigid plastic conduit (PVC) below slab. All raceway shall be located a minimum of 8" below bottom of slab. Install

RMC (with protective coating) for raceways passing vertically through slab-on-grade. Slope raceways as required to drain away from electrical enclosures and to avoid collection of moisture in raceway low points.

2. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.
3. Mark all buried conduits that do not require concrete encasement by placing yellow plastic marker tape (minimum 6" wide) along entire length of run 12" below final 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.
4. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.

Q. Raceway installation in suspended slabs: Not allowed.

R. Raceway installation in hazardous locations:

1. Install RMC in all hazardous locations as defined by NEC. Provide suitable fittings, seal-offs, boxes, etc. to comply with requirements.
2. Engage at least five full threads on all fittings. Provide inspection fittings with explosion proof drains to prevent water accumulation in conduit runs. Install seal-offs for arcing or high temperature equipment, at housing with splices or taps and where conduits enter or leave the hazardous area. Provide seal-offs of the appropriate type for vertical or horizontal installation. Ground all metallic parts.

S. DUCTBANKS:

1. Provide ductbank construction as indicated using 3000 psi at 28 day strength concrete. Use Type II low alkali per ASTM C150. Use ASTM C-33 aggregate gradation with maximum size of 3/4". Use W/C ratio of 0.50. Install #4 reinforcing bar per ASTM 615 grade 50 in each corner of ductbank. Provide minimum 4" concrete cover on all sides of exterior conduits. Provide polypropylene pull rope in all spare duct.

T. Electrical Identification: Refer to Section 260553 for requirements.

U. SPARE PARTS: Refer to Section 26 0502 for requirements.

END OF SECTION 26 0532

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SECTION 26 0533

ELECTRICAL BOXES AND FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to electrical wiring boxes and fittings specified herein. See Section 260532, Raceways, for additional requirements.

1.2 DESCRIPTION OF WORK:

- A. The extent of electrical box and electrical fitting work is indicated by drawings and schedules.
- B. Types of electrical boxes and fittings in this section include the following:
 - 1. Outlet Boxes
 - 2. Junction Boxes
 - 3. Pull Boxes
 - 4. Floor Boxes
 - 5. Conduit Bodies
 - 6. Bushings
 - 7. Locknuts
 - 8. Knockout Closures
 - 9. Miscellaneous Boxes and Fittings

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings. Comply with ANSI C 134,1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxes, covers and box supports. Provide electrical boxes and fittings that have been UL-listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS:

- A. INTERIOR OUTLET BOXES:
 - 1. Provide one piece, galvanized flat rolled sheet steel interior outlet wiring boxes with accessory rings, of types, shapes and sizes, including box depths, to suit each respective location and installation, construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box and covers and wiring devices; minimum size 4"x4"x2-1/8".
 - 2. Provide an 'FS' box, with no knockouts when surface mounted in a finished, non-utility space. Surface mounting is only acceptable when approved by the Architect.
- B. INTERIOR OUTLET BOX ACCESSORIES:

1. Provide outlet box accessories as required for each installation, including mounting brackets, hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, that are compatible with outlet boxes being used and fulfilling requirements of individual wiring applications.
- C. WEATHERPROOF OUTLET BOXES:
1. Provide corrosion-resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes (including depth) required, with threaded conduit ends, cast-metal face plates with spring-hinged waterproof caps suitably configured for each application, with face plate gaskets and corrosion-resistant fasteners.
- D. JUNCTION AND PULL BOXES:
1. Provide code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.
- E. FLOOR BOXES:
1. Single Service Floor Box: Provide leveling and fully adjustable floor service receptacle outlets and fittings of types and ratings indicated; and with finish as selected by Architect. Equip with wiring devices as specified in Section 262726. Provide boxes compatible with floor system; provide epoxy-coated stamped steel boxes or cast-iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall be available in one, two or three gang configurations. Boxes shall comply with UL Standard UL514A.
 2. Multi-Service Floor Box: Provide leveling and fully adjustable multi compartment floor box; there shall be multiple independent wiring compartments; the floor box shall permit tunneling from end power compartment to end power compartment. Floor box shall accommodate a minimum of two duplex receptacles and two mounting plates for telecommunication devices. Equip with wiring devices as specified in Section 262726. Provide boxes compatible with floor system; with finish as selected by Architect. Provide epoxy-coated stamped steel boxes or cast-iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall comply with UL Standards UL514A and/or UL514C.
 3. Manufacturer: subject to compliance with requirements, provide floor boxes of one of the following:
 - a. Bell Electric/Square D Co.
 - b. Crouse-Hinds Co.
 - c. Harvey Hubbell, Inc.
 - d. Thomas & Betts.
 - e. Wiremold
- F. CONDUIT BODIES:
1. Provide galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.
- G. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS:
1. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable steel conduit bushings and offset connectors, of types and sizes to suit respective uses and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. GENERAL:

1. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
2. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
3. Provide coverplates for all boxes. See Section 262726, Wiring Devices.
4. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
5. Provide knockout closures to cap unused knockout holes where blanks have been removed.
6. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Do not install boxes above ducts or behind equipment. Install recessed boxes with face of box or ring flush with adjacent surface. Seal between switch, receptacle and other outlet box openings and adjacent surfaces with plaster, grout, or similar suitable material.
7. Fasten boxes rigidly to substrates or structural surfaces, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them. Set boxes on opposite sides of fire-resistant walls with minimum of 24" separation.
8. Provide a minimum of 1 ½" from the nearest surface of the roof decking to the installed boxes.
9. Provide electrical connections for installed boxes.

END OF SECTION 26 0533

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SECTION 26 0548

ELECTRICAL SEISMIC CONTROL

PART 1 – GENERAL

1.1 WORK INCLUDED:

- A. Anchorage and seismic restraint systems for all Division 26 isolated and non-isolated equipment, cable tray, and conduit systems.
- B. Anchorage and seismic restrain systems for electrical components shall include but not be limited to the following:
 - 1. Pad Mounted Equipment
 - 2. Conduit
 - 3. Light Fixtures

1.2 RELATED WORK:

- A. Requirements: Provide Electrical Seismic Control in accordance with the Contract Documents.
- B. Section 260500 – Electrical General Provisions

1.3 REFERENCES:

- A. International Building Code, Current Edition in use by Jurisdictional Authority.
- B. NFPA Bulletin 90A, Current Edition.
- C. UL Standard 181.
- D. ASCE 7-10

1.4 SYSTEM DESCRIPTION

- A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:
 - 1. Short period design spectral response acceleration coefficient $SDS=1.12$.
 - 2. One second period design spectral response acceleration coefficient $SD1=0.62$.
 - 3. Soil Site Class D.
 - 4. Seismic Design Category D.
 - 5. Importance Factor (I_p) = 1.0
- B. Seismic Restraint Exceptions
 - 1. The following components are exempt from the requirements of this section:
None

1.5 QUALITY ASSURANCE:

- A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for electrical equipment. Shop drawings submitted for earthquake bracing and anchors shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26 equipment and systems shall be provided by a single firm.
- B. The above qualified seismic engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the

electrical equipment that have been submitted, reviewed and accepted by the Architect/Engineer for this project.

- C. Seismic Engineer or the Engineer's Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design. A certificate of compliance bearing the Seismic Engineer's signed Professional Engineer's seal shall be submitted and shall be included in each copy of the Operation and Maintenance Manuals.
- D. The Division 26 Contractor shall require all equipment suppliers furnish equipment that meets the seismic code, with bases/skids/curb designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings and certified correct by the equipment manufacturer for seismic description listed in Paragraph 1.4 above, with direct anchorage capability.

1.6 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS:

2.1 RESTRAINT EQUIPMENT AND SYSTEMS:

- A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:
 - 1. Mason Industries, Inc.
 - 2. Korfund
 - 3. Amber/Booth Company
 - 4. Vibration Mountings and Control Company
 - 5. Kinetics
 - 6. International Seismic Application Technology
 - 7. Tolco
- B. Manufacture and design of restraints and anchors for isolated equipment shall be by the manufacturer of the vibration isolators furnished for the equipment.

2.2 SNUBBERS:

- A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.
- B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.
- C. Snubbers shall be Mason Industries Z -1011 or accepted equivalent.

PART 3 – EXECUTION

3.1 DESIGN AND INSTALLATION:

- A. General:
 - 1. All electrical components shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials, and equipment for protection against seismic disturbances as specified herein. The following electrical components are exempt from seismic restraint requirements.
 - a. Electrical components in Seismic Design Category A or B (see section 1.4)
 - b. Electrical components in Seismic Design Category C provided that the component importance factor, I_p , is equal to 1.0 (see section 1.4).

c. Electrical components in Seismic Design Categories D, E, or F where all of the following apply:

- i. The component importance factor, I_p , is equal to 1.0;
- ii. The component is positively attached to the structure;
- iii. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and either
 1. The component weighs 400 lb (1,780 N) or less and has a center of mass located 4 ft (1.22 m) or less above the adjacent floor level; or
 2. The component weighs 20 lb (89 N) or less or, in the case of a distributed system, 5 lb/ft (73 N/m) or less.

2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.

3. Attachments and supports for electrical equipment shall meet the following provisions:

- a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).
- b. Friction clips shall not be used for anchorage attachment.
- c. Expansion anchors shall not be used for electrical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.
- d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.
- e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.
- f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$. The intent is to prevent excessive movement and to avoid fracture of support springs and any non-ductile components of the isolators.
- g. Seismic supports shall be constructed so that support engagement is maintained.

B. Pad Mounted Equipment

1. Spring Isolated Equipment:

- a. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.

2. Non-Isolated Equipment:

- a. The section 260548 (Electrical Seismic Control) Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment i.e. switchboards, transformers, generators, etc. to be restrained. This Contractor shall be responsible for certifying that this equipment is mounted and braced such that it adheres to the system description criteria in part 1.4 of this specification section.

C. Conduit, Conduit Racks/Trapeze Assemblies:

1. Seismic braces for be omitted when the distance from the supporting structure to the raceway support point is 12" or less. Where rod hangers are used, they shall be equipped with swivels to prevent inelastic bending in the rod.
2. Seismic braces may be omitted where the total weight of the assembly is less than 10 lb/ft.
3. Seismic braces for individual conduit may be omitted for conduit less than 2.5 inch trade size.
4. A rigid conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
5. Unbraced conduit attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
6. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
7. Provide large enough pipe sleeves through wall or floors to allow for anticipated differential movements.
8. For spaces, where the Importance Factor (I_p) is equal to 1.5, all electrical components that are attached to structures that could displace relative to one another and for isolated structures where components cross the isolation interface, the components shall be designed to accommodate the seismic relative displacements.

D. Light Fixtures

1. Light fixtures, lighted signs, and ceiling fans not connected to ducts or piping, which are supported by chains or otherwise suspended from the structure, are not required to satisfy the seismic force and relative displacement requirements provided they meet all of the following criteria:
 - a. The design load for such items shall be equal to 1.4 times the operating weight acting down with a simultaneous horizontal load equal to 1.4 times the operating weight. The horizontal load shall be applied in the direction that results in the most critical loading for the design.
 - b. Seismic interaction effects shall not cause an effect so that the failure of the non-essential component causes a failure of an essential component.
 - c. The connection to the structure shall allow a 360° range of motion in the horizontal plane.
 - d. The component is less than 20 lbs and has flexible connections and an importance factor (I_p) equal to 0.

END OF SECTION 26 0548

SECTION 26 0553

ELECTRICAL IDENTIFICATION

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 work of this section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. "Basic Electrical Requirements".
 - 2. "Basic Electrical Materials and Methods".

1.2 SUMMARY

- A. This section includes identification of electrical materials, equipment and installations. It includes requirements for electrical identification components including but not limited to the following:
 - 1. Buried electrical line warnings.
 - 2. Identification labels for raceways, cables and conductors.
 - 3. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.
 - 6. Arc-flash hazard labels
- B. Related Sections: The following sections contain requirements that relate to this section:
- C. Division 9 Section "Painting" for related identification requirements.
- D. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.3 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code"

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. American Labelmark Co.
 - 2. Calpico, Inc.
 - 3. Cole-Flex Corp.
 - 4. Emed Co., Inc.
 - 5. George-Ingraham Corp.
 - 6. Ideal Industries, Inc.
 - 7. Kraftbilt
 - 8. LEM Products, Inc.

9. Markal Corp
10. National Band and Tag Co.
11. Panduit Corp.
12. Radar Engineers Div., EPIC Corp.
13. Seton Name Plate Co.
14. Standard Signs, Inc.
15. W.H Brady, Co.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Conduit Systems for raceway identification:
 1. Factory-painted conduit and/or factory-painted couplings and fittings
- B. Colored paint for raceway identification:
 1. Use [Kwal Paint](#) colors as specified in Part 3 – Execution.
- C. Color Adhesive Marking Tape for Raceways, Wires and Cables:
 1. Self-adhesive vinyl tape not less than 3 mills thick by 1" to 2" in width.
- D. Underground Line Detectable Marking Tape:
 1. Permanent, bright colored, continuous-printed, acid- and alkali-resistant plastic tape specifically compounded for direct-burial service. Not less than 6" wide by 4 mills thick.
 2. With metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
 3. Printed legend indicative of general type of underground line below.
- E. Wire/Cable Designation Tape Markers:
 1. Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letters.
- F. Brass or Aluminum Tags:
 1. Metal tags with stamped legend, punched for fastener.
 2. Dimensions: 2" X 2" 19 gage.
- G. Engraved, Plastic Laminated Labels, Signs and Instruction Plates:
 1. Engraving stock plastic laminate, 1/16" minimum thickness for signs up to 20 sq. in. or 8" in length; 1/8 " thick for larger sizes. Engraved legend in 1/4" high white letters on black face and punched for mechanical fasteners.
- H. Arc-flash Hazard Labels:
 1. ANSI Z535.4 Safety Label.
 2. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
 3. Dimensions: 5" x 3.5"
 4. Information contained: Arc-flash boundary; Voltage; Flash Hazard Category; Incident Energy (arc rating); checkboxes for the required Personal Protective Equipment (PPE) and the date that the calculations were performed.
- I. Equipment Labels:
 1. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
 2. Dimensions: minimum 5" x 2"
 3. Conductor-Identification-Means Labels:

- a. Information contained: the method utilized for identifying ungrounded conductors within switchboards, distribution panels and branch circuit panels.
- 4. Available-Fault-Current Labels:
 - a. Information contained: maximum available fault current at the respective piece of equipment, and date of calculation of fault current.
- 5. Source-of-Supply Labels:
 - a. Information contained: indicate the device or equipment where the power supply originates.
- J. Baked Enamel Warning and Caution Signs for Interior Use:
 - 1. Preprinted aluminum signs, punched for fasteners, with colors legend and size appropriate to location.
- K. Fasteners for Plastic-Laminated and Metal Signs:
 - 1. Self-tapping stainless-steel screws or # 10/32 stainless steel machine screws with nuts, flat and lock washers.
- L. Cable Ties:
 - 1. Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18" minimum width, 50-lb. Minimum tensile strength, and suitable for a temperature range from minus 40° F. to 185° F. Provide ties for specified colors when used for color coding.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics:
 - 1. Coordinate names, abbreviations, colors and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work:
 - 1. Where identification is to be applied to surfaces that require a finish, install identification after completion of finish work.
- D. Conduit Identification:
 - 1. Identify Raceways of Certain Systems with Color Coding. Acceptable means of color identification are as follows:
 - a. Colored adhesive marking tape.
 - b. Field-painted colored bands.
 - c. Factory-painted conduit.
 - d. Color exposed or accessible raceways of the following systems for identification. Make each color band 2 inches wide, completely encircling conduit. Apply bands at changes in direction, at penetrations of walls and floors, and at 20-foot maximum intervals in straight runs. Apply the following colors:
 - i. Fire Alarm System: Red
 - ii. Sound/IC: Blue
 - iii. Telephone: Yellow

- iv. Data: Green
 - v. MATV: Black
 - vi. Security: Orange
2. Identify Junction, Pull and Connection Boxes.
- a. Code-required caution sign for boxes shall be pressured-sensitive, self-adhesive label indication system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers on outside of cover with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.
3. Label and paint the covers of the systems junction boxes as follows:

<u>SYSTEM</u>	<u>COLOR (ALL COLORS ARE KWAL PAINT)</u>	
Fire Alarm	Red Alert	AC118R
Sound/IC	Neon Blue	7076A
Telephone	Competition Yellow	7225A
Data	Java Green	AC098N
MATV	Flat Black	
Security	Fiesta Orange	AC107Y

E. Underground Electrical Line Identification.

1. During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground line detectable marking tape, located directly above line at 6 to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
2. Install detectable marking tape for all underground wiring, both direct-buried and in raceway.
3. Provide red marker dye applied to concrete encased ductbank.

F. Conductor Color Coding.

1. Provide color coding for secondary service, feeder and branch circuit conductors throughout the project secondary electrical system as follows:

<u>CONDUCTOR</u>	<u>208Y / 120V System</u>	<u>480Y / 277V System</u>
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Shared/Single Neutral	White	Gray
Neutral A (dedicated)	White w/Black Stripe	Gray w/Black Stripe
Neutral B (dedicated)	White w/Red Stripe	Gray w/Orange Stipe
Neutral C (dedicated)	White w/Blue Stripe	Gray w/Yellow Stipe
Equipment Ground	Green	Green
Isolated Ground	Green w/Yellow Strip	Green w/Yellow Stripe

2. Switch legs, travelers and other wiring for branch circuits shall be of colors other than those listed above.

3. Use conductors with color factory applied the entire length of the conductors except as follows:
 - a. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

G. Power Circuit Identification.

1. Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb monofilament line or one-piece self-locking nylon cable ties.
2. Tag or label conductors as follows:
 - a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
 - b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/ signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

H. Apply warning, caution and instruction signs and stencils as follows:

1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items. Warning and caution signs shall be furnished and installed on, but not be limited to the following equipment and locations:
 - a. Entrances to rooms and other guarded locations that contain exposed live parts 600 volts or less; signs shall forbid unqualified personnel to enter.

- b. Switch and Overcurrent device enclosures with splices, taps and feed-through conductors. Provide warning label on the enclosures that identifies the nearest disconnecting means for any feed-through conductors.
 - c. Entrances to buildings, vaults, rooms or enclosures containing exposed live parts or exposed conductors operating at over 600 volts: DANGER-HIGH VOLTAGE-KEEP OUT.
 - d. Metal-enclosed switchgear, unit substations, transformers, enclosures, pull boxes, connection boxes and similar equipment operating at over 600 volts shall have appropriate caution signs and warning labels.
 - e. Indoor and Outdoor substations operating over 600 volts. Provide warning signs, instructional signs and single-line diagrams in accordance with NEC 225.70.
- I. Emergency Operating Signs: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- J. Install equipment/system circuit/device identification as follows:
 - 1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/4"-high lettering on 1-inch-high label (1 1/2-inch-high where two lines are required) white lettering in black field. White lettering in red field for Emergency Power Systems. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
 - a. Each service disconnect, to identify it as a service disconnect.
 - b. Panelboards (exterior and interior), electrical cabinets, and enclosures. For subpanels, identify feeder circuit served from.
 - c. Switches in fusible panelboards shall be labeled. Main switches shall be identified.
 - d. Access doors and panels for concealed electrical items.
 - e. Electrical switchgear and switchboards.
 - f. Motor starters, including circuit origination, HP, heater size, FLA, and mechanical equipment designation.
 - g. Disconnect switches.
 - h. Pushbutton stations.
 - i. Contactors.
 - j. Dimmers.
 - k. Control devices.
 - l. Transformers.
 - m. Power generating units, to include transfer switches.
 - n. TV/audio monitoring master station.
 - o. Fire alarm master station or control panel.
 - p. Variable frequency drives.
 - q. Lighting Control Equipment.
- K. Post Conductor-Identification-Means labels at locations of switchboards, distribution panels and branch circuit panels. The labels shall identify the color-coding used on ungrounded conductors for each voltage system used on the premises.

- L. Apply Available-Fault-Current labels at the service entrance equipment.
- M. Apply Source-of-Supply labels on the exterior covers of equipment (except in single- or two-family dwellings) as follows:
 - 1. Each switchboard supplied by a feeder.
 - 2. Each branch circuit panelboard supplied by a feeder.
 - 3. Each disconnect switch serving elevators, escalators, moving walks, chairlifts, platform lifts and dumbwaiters.
 - 4. Each dry type transformer (or primary-side disconnect switch at transformer). If the primary-side disconnect is remote from the transformer, both the remote disconnect and the transformer shall be labeled, and the transformer label shall also indicate the location of the disconnect.
 - 5. Each feeder disconnect, branch circuit disconnect, panelboard or switchboard in a remote building or structure.
 - 6. Each on-site emergency power source, with sign placed at service entrance equipment to comply with NEC 700.
- N. The label shall identify the device or equipment where the power supply originates, and the system voltage and phase. For example: Feeder Power Supply for Panel "XX" Originates at Panel "XX" (or Switchboard "XX", Transformer "XX", Switch "XX", etc.); 120/208 volts, 3-phase (or 120/240, 277/480, etc.).
- O. Install Arc-flash hazard labels on the following equipment:
 - 1. Each piece of service entrance equipment.
 - 2. Each power distribution switchboard or panel.
 - 3. Each branch circuit panelboard.
 - 4. Each individually mounted motor starter.
 - 5. Each meter socket enclosure.
- P. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.
- Q. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- R. Engrave all receptacle plates other than those serving 120-volt, single phase devices. State voltage and amperage characteristics: Example; "208V 30A".
- S. Mark each device box (for each type of wiring device) with a permanent ink felt tip marker, indicating the circuit that the device is connected to: Example; "CKT A-1"
- T. Label circuit breaker feeding fire alarm panel "Fire Alarm Circuit". Using plastic laminate label, white lettering on a red background.

END OF SECTION 26 0553

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SECTION 26 0573

PROTECTIVE DEVICE STUDY

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 work of this section.

1.2 DESCRIPTION OF WORK:

- A. Studies in this section include the following:
 - 1. Fault current protective device and equipment evaluation
 - 2. Protective device coordination study
 - 3. Arc-flash hazard analysis and study

1.3 QUALITY ASSURANCE:

- A. Provide protective device and arc-flash hazard studies performed by qualified engineers of the equipment manufacturer or an approved consultant. Studies must bear the professional engineer's stamp of the engineer in responsible charge of the protective device studies. Perform all work in accordance with latest IEEE and ANSI standards.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – STUDIES

2.1 FAULT CURRENT PROTECTIVE DEVICE & EQUIPMENT EVALUATION

- A. Perform fault current analysis with the aid of a computer and appropriate software. Include as input data the maximum available short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.
- B. Coordination Criteria:
 - 1. All overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault's duration extends beyond 0.1 second.
 - 2. Coordination shall not be required as follows:
 - a. Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exist on the transformer secondary.
 - b. Between overcurrent protective devices of the same size (ampere rating) in series.
- C. Calculate fault current close and latch duty values and interrupting duty values on the basis of assumed three-phase bolted short circuits at each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, branch circuit panel and other significant locations throughout the system. Include symmetrical fault currents, and X/R ratios in the fault current tabulations. For each fault location, list the total duty on the bus, as well as the individual contribution from each connected branch, with its respective X/R ratio. Calculate ground fault currents at each bus. Incorporate major motor contributions in determining momentary and interrupting

ratings of protection devices.

- D. Perform an evaluation to determine the adequacy of circuit breakers, molded case switches, automatic transfer switches, and fuses, by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards. Report problem areas or inadequacies in the equipment due to short circuit currents prior to release for fabrication of switchgear, switchboards and/or appliance panelboard.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Perform a protective device coordination study including the necessary calculations and logic decisions required to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. Perform the studies in accordance with the latest applicable IEEE and ANSI standards.
- B. Include all medium and low voltage classes of equipment in the coordination study from the building or plant service protective devices down to and including the largest rated device in the low voltage motor control centers and panelboards. Include the phase and ground overcurrent protection as well as settings of all other adjustable protective devices.
- C. Develop time-current characteristics of the specified protective devices on log-log paper. Include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. Indicate on plots the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. Adhere to all restrictions of the National Electrical Code. Maintain proper coordination intervals and separation of characteristic curves.
- D. Provide coordination plots for phase and ground protective devices on a system basis. Provide a sufficient number of separate curves to clearly indicate the coordination achieved.
- E. Provide the selection and settings of the protective devices in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment and recommended settings. Provide a tabulation of the recommended power fuse selection for medium voltage fuses where applied in the system. Promptly report any discrepancies, problem areas, or inadequacies prior to release for fabrication of switchgear, switchboards and/or appliance panels.

2.3 ARC-FLASH HAZARD ANALYSIS AND STUDY

- A. Perform an arc-flash hazard analysis and study. Include the necessary calculations required to determine the level of Personal Protection Equipment (PPE) that a worker must use, the Arc Flash Boundary in inches, and the incident energy at each location. This information shall be calculated and determined for each piece of service entrance equipment, each power distribution switchboard or panel, each separately-mounted circuit breaker, each motor control center, each individually mounted motor starter, and for each branch circuit panelboard.
- B. Perform the analysis and study in accordance with IEEE 1584.
- C. Furnish and install a label at each piece of service equipment, each power distribution switchboard or panel, each separately mounted circuit breaker, each motor control center, each individually mounted motor starter, and each branch circuit panel board. The label shall be an ANSI approved Arc Flash Warning Label that warns and instructs workers of the arc flash hazard, voltage, arc flash boundary, and required PPE (Personal Protective Equipment).

2.4 ANALYSIS/REPORT

- A. Include the following in the report.
1. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system that is included within the scope of the study.
 2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding same. Include formulas and description of methods used.
 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
 4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
 5. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays, circuit breakers, etc.
 6. Tabulation of arc-flash calculations for each location and tabulation of arc-flash hazard, voltage, boundary and required PPE for each equipment item listed in the arc-flash analysis.

2.5 PROTECTIVE DEVICE TESTING, CALIBRATION AND ADJUSTMENT

- A. Provide the services of a qualified field engineer employed by the equipment manufacturer, and necessary tools and equipment to test, calibrate and adjust the protective relays, ground fault relays and circuit breaker trip devices as recommended in the Protective Device Study.

2.6 TYPEWRITTEN DEVICE SETTING TABULATION:

- A. Provide type written tabulation that includes all settings for each protective relay, ground fault relay and circuit breaker solid-state trip devices. Enclose the table in a protective plastic sleeve and affix to the main service entrance equipment.

END OF SECTION 26 0573

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SECTION 26 0923

OCCUPANCY SENSORS

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK:

- A. The extent of occupancy sensor work is indicated by drawings and schedules.
- B. Types of occupancy sensors in this section include the following:
 - 1. Dual Technology Wall Switch
 - 2. Dual Technology Wall Switch with Dimming and Daylight Control.
 - 3. Dual Technology Ceiling Sensor w/ Control Pack

1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of occupancy sensors. Provide occupancy sensors that have been UL listed and labeled.
- B. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems, motor loads and any other passive infrared or microwave systems.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER: The manufacturer shall have a minimum of five years of experience in the sensor and lighting control industry. Sensors and related relays shall be compatible with the specific lighting types controlled. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable.

- A. DUAL TECHNOLOGY WALL SWITCH: Where units are indicated provide a sensor that meets the following minimum requirements:
 - 1. Sensor shall utilize PIR (Passive Infrared) to turn on the lights and then PIR or US (Ultrasonic) technologies to keep lights on.
 - 2. Sensor shall incorporate an inrush current limiter circuit to protect the relay contacts.
 - 3. Sensor shall utilize single or dual dry relay contacts for control of the lighting loads. Contractor shall verify requirements in coordination with the drawings.
 - 4. Sensor shall have a self-adjusting time delay, selectable 5, 15 and 30 minutes.
 - 5. Sensor shall have automatic sensitivity adjustment and be microprocessor controlled.
 - 6. Sensor shall have light level sensing 0 to 200 footcandles.
 - 7. Sensor shall have a 180 degree field of view, coverage up to 800 square feet and shall detect 6 inches of hand movement towards the sensor up to 300 square feet; and body motion towards the sensor up to 1000 square feet.
 - 8. Sensor shall be rated for 0 to 800 watts at 120VAC and 0 to 1200 watts at 277VAC.

9. Sensor shall be automatic on and shall have an automatic to off override switch on the unit. Switch shall be equipped with an air gap switch to disconnect power to the lighting load.
 10. Sensor shall have real time motion indicator on the front of the unit.
 11. Sensor shall mount to a single gang switch box.
 12. Subject to compliance with the above requirements. Provide models of one of the following:
 - a. Greengate ONW-DT
 - b. Sensor Switch WSX PDT Series
 - c. Douglas WOS Series
- B. DUAL TECHNOLOGY WALL SWITCH WITH DIMMING AND DAY-LIGHT CONTROL:
Where units are indicated, provide a sensor that meets the following minimum requirements:
1. Dual technology sensors shall have one of its two technologies, not require motion to detect occupancy.
 2. Sensors shall offer a minimum on timer of at least 15 minutes, in order to prevent all cycling of lamps before they have burned for the lamp manufacturers minimum recommended time period.
 3. Sensors shall utilize an occupancy time delay that keeps lights on after last detected occupancy. Factory default setting of the occupancy time delay shall be 15 minutes.
 4. Manual adjustment to the occupancy time delay so as to increase it shall be accommodated.
 5. Sensor shall be capable of switching both 120 VAC and 277 VAC.
 6. Sensor shall recess into single gang switch box and fit standard GFI opening.
 7. Sensor shall meet NEC grounding requirements by providing a dedicated ground connection and intrinsically grounding through its mounting strap.
 8. Line and load wire connections shall be interchangeable.
 9. Wall switch sensor shall have field programmable adjustments for selecting operational modes, occupancy time delays, minimum on time, and photocell set-point.
 10. Sensor shall be capable of both auto-on and manual operation.
 11. Combination photocell/dimming sensors set point and deadband shall be automatically calibrated through the sensors microprocessor by initiating the automatic set point programming procedure. Min and max dim settings as well as set point may be manually entered.
 12. Subject to compliance with the above requirements, provide models of one of the following:
 - a. Sensor-Switch – WSX-PDT-D Series
 - b. Green Gate – CSW-d-010

- C. DUAL TECHNOLOGY CEILING SENSOR: Where units are indicated, provide a sensor that meets the following minimum requirements:
1. Sensor shall incorporate ultrasonic (microphonics) and infrared technologies in a single unit.
 2. Sensor shall be Class 2, low voltage; capable of mounting in the ceiling for maximum coverage.
 3. Sensor shall use internal microprocessor for motion signal analysis and automatic self-adjustment.
 4. Sensor shall have automatic self-adjustment algorithm that adjusts timer and sensitivity settings to maximize performance and minimize energy usage.
 5. Sensor shall have manual time-out adjustment from 8 minutes to 32 minutes and automatic time out from 8 minutes to 100 minutes.
 6. Sensor shall have test time-out setting of 8 seconds, with automatic return to 8 minutes after one hour if sensor is left in test mode.
 7. Sensor's microprocessor shall automatically extend timer by 1 hour in response to recognition to false off condition. After 5 hours, sensor reduces extended time by 30 minutes and continues to reduce by 30 minute increments over the next few days.
 8. Sensor's microprocessor shall automatically reduce either PIR or ultrasonic sensitivity in response to false on condition.
 9. Sensor microprocessor will automatically monitor PIR background threshold signal level and makes corresponding sensitivity adjustments automatically.
 10. Sensor microprocessor algorithm shall incorporate automatic adaptation to continuous airflow.
 11. For airflow that is so intense as to mask motion, sensor shall flash indicator LED code to indicate excessive airflow.
 12. Sensor's microprocessor shall use a four week learning period and develop a circadian calendar.
 13. An internal 24 hour 7 day clock establishes what periods the room is typically occupied, biasing sensor to keep lights on while normally occupied and off when normally unoccupied.
 14. Sensor shall have selection settings for the following dual technology schemes:
 - a. High Sensitivity and High Confidence (miser mode)
 15. Sensor shall be available with either 180 degrees or 360 degrees coverage pattern.
 16. Infrared lens shall have 360 degree field of view. Two types of lens shall be available, standard and extra dense.
 17. Sensor shall have a variety of mask inserts for PIR coverage rejection to prevent false tripping.
 18. Transducers shall be protected from tampering.
 19. Sensor shall have manual adjustments for timer and sensitivities and override switches to force manual adjustment mode.
 20. Sensor shall have adjustable sensitivity from 0% to 100% for both ultrasonic and infrared.
 21. Controls shall be behind cover to resist tampering. All adjustments shall be accessible from the front of the sensor.
 22. Sensor shall be available with a photocell adjustment from 20 to 3,000 Lux.
 23. Sensor shall provide internal operating status and settings confirmation via LED motion lamp indicator.

24. Sensor shall have two (if 180 degree) or three (if 360 degree) real time LED motion indicators visible from the front of the unit: Red = infrared; green = ultrasonic.
 25. Subject to compliance with the above requirements, provide models of one of the following:
 - a. Hubbell-ATD Series
 - b. Sensor Switch-CM-PDT 9/10 Series
 - c. Wattstopper-DT Series
 - d. Mytech-Omni-DT Series
 - e. Leviton – OSC UOW Series
 - f. Greengate OAC– DT Series
 - g. Douglas – WOR Series
- D. 24 VDC POWER/CONTROL PACK: Where units are indicated, provide a power/control pack that meets the following minimum requirements:
1. Control module shall consist of a DC power supply and a dry contact relay for switching a lighting load.
 2. Control module shall be available in versions to accept 120, and 277 VAC line voltages.
 3. Output shall be 24VDC nominal, and shall be inherently safe, low voltage, limited power output (Class 2).
 4. Output shall supply 100mA current, in addition to current consumed internally to operate internal relay.
 5. Relay shall utilize normally open, silver alloy dry contacts, and shall be rated for a 20A ballast load at 120V and 277V.
 6. Relay function shall not require more than 5 mA control current to operate.
 7. Control module shall have line voltage wiring, consisting of input voltage and relay contact connections, exiting from one end, and low voltage DC connections, consisting of ground, power, and control wires, exiting from the other end.
 8. Control module shall be sized to fit inside a standard 4" x 4" junction box.
 9. Control module shall be equipped with a 1/2" EMT threaded male fitting on the line voltage end, such that it may be mounted to the outside of a junction box with the line voltage wiring internal to the box and the low voltage wiring external.
 10. Control module shall be equipable with accessory 1/2" EMT threaded male fitting on the low voltage end, such that it may be mounted to the inside of a ballast cavity with the box and line voltage wiring internal to the cavity and the low voltage wiring external.
 11. Slave module shall be available for switching additional circuits. Slave module has same construction and specifications as control module except without power supply function.
 12. Subject to compliance with the above requirements, provide models of one of the following:
 - a. Hubbell-CU Series
 - b. Sensor Switch-MP20 Series
 - c. Wattstopper-BEP Series
 - d. Mytech-MP Series
 - e. Greengate SP20-MV Series
 - f. Leviton – OSC/OSA Series

PART 3 – EXECUTION

3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

- A. Install occupancy lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.
- B. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.
- C. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.
- D. Contractor shall be on site as required, to adjust lighting control units for proper operation.
- E. Mount the switchpack in a standard 4" junction box. Mount sensor to a standard 4" junction boxes. Refer to manufacturer supplied mounting instructions.
- F. Spare Parts: Refer to Section 26 0502 for requirements.

3.2 FIELD QUALITY CONTROL:

- A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.
- B. System start-up: Provide a factory authorized technician to verify the installation and test the system.
- C. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. Contractor shall visit the job site 3 months after the owner has taken occupancy and adjust any units not operating properly, otherwise remove and replace with new units.

3.3 PRODUCT SUPPORT AND SERVICES:

- A. System Start-Up: Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:
 - 1. The sensors have been fully installed in accordance with manufacturer's installation instructions.
 - 2. Low voltage wiring for overrides and sensors is completed.
 - 3. Accurate 'as-built' load schedules have been prepared.
 - 4. Proper notification of the impending start-up has been provided to the owner's representative.
 - 5. Programming of all switches, sensors, power packs, relays, etc. shall be completed by factory authorized technician, prior to final and training.
- B. Factory support: Factory telephone support shall be available at no cost to the owner during the warranty period. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll-free number for technical support.
- C. Functional Testing:
 - 1. The contractor shall hire a third party that will conduct and certify the functional

testing.

2. Lighting controls devices shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working conditions in accordance with the construction documents, manufacturer's instructions and code requirements. The following shall be performed:
 - a. Certify that sensors have been located, aimed and calibrated per manufacturer recommendations.
 - b. Status indicator operates properly.
 - c. Fixtures that are controlled by auto-on controls turn on to permitted level.
 - d. Fixtures that are controlled by manual on controls operate when manually activated.
 - e. Fixtures do not turn on incorrectly due to HVAC or movement outside the controlled area.
 - f. Confirm that occupancy sensors turn off after space is vacated and do not turn on unless space is occupied.
 - g. Simulate unoccupied conditions and confirm that vacancy sensors only turn on manually and turn off after space is vacated.
3. The party responsible for the functional testing shall provide documentation that the installed lighting controls meet or exceed all performance criteria and shall not be directly involved in the design or construction of the project.

3.4 WARRANTY:

- A. Manufacturer shall provide a one (1) year limited warranty on lighting control system. A ten (10) year limited warranty shall be provided on the lighting control relays.

3.5 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

3.6 TRAINING

- A. Provide four (4) hours of video taped training in two 2-hour sessions on the operation and use of the lighting control equipment, at job site, at no cost to the Owner.

3.7 MANUFACTURER AUTHORIZED PERSONNEL TRAINING:

- A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment.

END OF SECTION 26 0923

SECTION 26 0943

LIGHTING CONTROL EQUIPMENT

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 work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK

- A. Extent of lighting control equipment work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, lighting control panels, control stations and other user interface devices, wiring and ancillary equipment.
- B. Types of lighting control equipment specified in this section, includes the following:
 - 1. Low voltage relay control panels
 - 2. Wall stations
 - 3. Occupancy sensors
 - 4. Daylight photosensor
 - 5. DMX Controls for RGBW fixtures. Contractor allowance pricing provided for the DMX control system of the RGBW fixtures that are part of the type O3 fixture around the ice ribbon. See fixture schedule.
- C. Requirements are indicated elsewhere in these specifications for work including but not limited to raceways, electrical boxes and fittings required for installation of lighting control equipment, not work of this section.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture 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. To ensure a uniform installation and single responsibility, all switching and dimming equipment described herein shall be supplied by a single manufacturer.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with lighting control equipment installation work similar to that required for project.
- C. NEC Compliance: The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.
- D. NEMA Compliance: The control system shall comply with all applicable portions of the NEMA Standard regarding the types of electrical equipment enclosure.
- E. Codes and Standards: Provide units that meet the requirements of IEEE Std. 2000.1.1999.
- F. Independent Testing Laboratory: Provide units that have been tested and listed under UL 916 energy management equipment.
- G. Component Pre-testing: All control equipment shall undergo strict inspection standards.

The equipment shall be previously tested and burned-in at the factory prior to installation.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide lighting control equipment of one of the following;
1. [Douglas Lighting Controls](#)
 2. [Cooper Lighting](#)
 3. [Acuity](#)
 4. [Lutron](#)
 5. [Wattstopper](#)
 6. [Hubbell Controls](#)
 7. DMX Controls - [Nicoladudie](#)

2.2 SYSTEM DESCRIPTION

- A. The DMX control system shall provide:
1. Touchpad – Stick DE3 (located in Ice Building office with view of Commons)
 - a. Touch sensitive design
 - b. Glass design
 - c. Color wheel for color selection
 - d. Multi-zone memory
 - e. Color temp mixing
 - f. 500 scene, 10 zones available
 - g. 1-24 DMX Channels
 - h. USB, RS2323 & Ethernet Connectivity
 - i. Clock/calendar
 - j. Windows/Mac compatible software
 - k. Android/iPhone/iPad remote and programming apps
 - l. Double gang box allows for installation of power supply
 2. ESA2 free downloadable software
 3. Individual fixture control of each of the 3 RGBW floods.
- B. The lighting control system shall provide seamless control and monitoring of all lighting included in the scope of work regardless of whether it is relay switched or dimmed.
- C. The lighting control system shall consist of low voltage relay control panels with programmable switch inputs, the panel shall be microprocessor controlled with a touchscreen interface display. The touchscreen shall provide relay status information viewable through a protected windowed enclosure. All local programming shall be permissible through the self-prompting touchscreen.
- D. Programmable intelligence shall include:
1. Time of day control (64 time-of-day/holiday schedules)
 2. 32 holiday dates
 3. Timed inputs (adjustable from 1 to 99 minutes)
 4. Timed override (from touchscreen, adjustable from 1 to 999 minutes, then resumes normal schedule)
 5. Pre-set controls

6. Auto daylight savings adjust
 7. Astronomical clock with offsets
 8. Local control (from touchscreen and local switch)
 9. Digital switches
 10. Flash warning of impending off for occupants
 11. Network override
- E. The controller shall permit lighting to be overridden on for after-hours use or cleaning. The controller shall provide priority and masking choices to allow for customizing the functions of switch inputs, thereby enabling switches to function differently at different times of day. These overrides shall be digital, network or hard-wired inputs.
- F. The lighting control system shall be fully programmable through PC programming software. Programming shall be permitted through a direct RS-232 connection, modem or TCP/IP.
- G. The control system shall provide networking between lighting control panels. The network shall support up to a maximum of 254 control panels. Panels shall permit data sharing for global controls. All inputs shall be transferable over the network to create any switching pattern.
- H. The lighting control system shall log all control events. Log reports shall be available through the integral touchscreen or enterprise software.

2.3 EQUIPMENT

A. Relay Panel

1. Enclosure: Shall be NEMA 1 rated, code gauge steel cabinet. Enclosure and contents shall be designed to operate in interior spaces with temperatures of 32°F - 104°F (0°-40°C) and 0-90% non-condensing humidity. Enclosure shall be available with optional recessed mounting hardware. See drawings for mounting requirements and refer to schedules on drawings for sizes.
2. Interior: Interiors shall be sized to accept relays and will provide true on/off indication of relay status through LED's. The system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on quick release hinge pins. All connections for the dry contact inputs shall incorporate modular connectors.
3. Power Supply: The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltage of 120 and 277 VAC shall be available with each control panel.
4. Cover: Provide surface cover with captive screws in hinged, lockable configuration. A wiring schedule directory card shall be affixed to the covers back to allow identification of circuits/relays/load controlled. Schedules must be typed and related to final room names and numbers (not bid document room names and numbers).
5. High Voltage Barrier: The controller shall provide the ability to provide for either voltage separation or emergency circuit separation.
6. Relays: The system shall utilize normally open control relays, that are rated to 20A at 120/277 VAC. The relays shall be mechanically latching, and shall permit individual override and LED configuration of relay status. The relays shall be rated for 10 million operations.
7. System Controller: The system controller shall consist of an integral touchscreen that provides access to the main programming features. The touchscreen shall

permit the user to manually command any or all relays individually.

- a. Provide master on/off control of a relay group while still allowing individual relays to be overridden by their local switch.
 - b. The control system shall permit up to 32 dry contact inputs for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Any input shall be software linked to any number of relays.
 - c. The controller shall provide timers for each override. Each override timer shall be capable of 0-999 minutes. Software shall enable or disable overrides based on priorities, masks or time of day scheduling.
 - d. The controller shall accept either dry contact or analog ambient light sensors. The controller shall provide power for the sensor. Sensors shall provide for outdoor, indoor or skylight applications and issue a command to the controller once the threshold is reached.
 - e. Each control panel shall incorporate diagnostic aids for confirmation of proper operation. The control panel shall employ both a backlit touchscreen and LED's to indicate:
 - i. Power
 - ii. System OK
 - iii. Network communications
 - iv. System clock and date
 - v. Programming confirmation
 - vi. Control panel subnet network communications
8. Switches: The lighting controller shall support digitally addressable LED annunciated switches. Provide low voltage push-button switches in up to 6 button configurations. Provide factory engraved labeling for individual push-buttons. Provide in color to match wiring devices and coverplate to match devices and plates in Wiring Devices (Section 26 2726).
9. Wiring:
- a. Provide CAT5 cable between switches and controller to create a digital switch network.
 - b. Provide CAT5 cable between controller and other controllers via a RS-485 network. The RS-485 network shall support up to 250 controllers with a maximum distance of 4000 feet.
 - c. Programming: Provide a RS-232 (RJ-R Connection) to allow programming through either a local connection or remotely through a modem.
 - d. Provide wiring in conduit located within the walls and non-accessible ceilings. Provide wiring above accessible ceilings in conduit to system enclosure to system enclosure.
10. Optional Accessories: Provide the following accessories;
- a. Enterprise Software: Provide a PC based interface software that provide access to the lighting control system files within a Windows® environment. The software shall allow individual or network panel programming to be executed locally, via direct connection or remotely through a TCP/IP connection or modem.
 - b. Ethernet Interface Module: Provide access to the control panels over a TCP/IP connection by converting sent information into RS-232 communication capable information.
 - c. Modem: The control panel shall provide a serial communications port for external telecommunications. The modem shall utilize the Hayes compatibility standard and enable modem access as defined by Bell

212A and CCITT V-22 Protocol Standards.

- d. Automation Interface Module: The control panel shall provide for data protocol translation and permit systems that utilize the Modbus® N2, BACnet or LonWorks communication protocols to operate individual relays or relay groups.
11. Ceiling Mounted Occupancy Sensors: Sensors shall utilize dual-technology (ultrasonic and infrared technologies) and have the following additional features:
- a. Sensor shall be class 2, low voltage; capable of mounting in the ceiling for maximum coverage.
 - b. Sensor shall have automatic self-adjustment algorithm that adjusts timer and sensitivity settings to maximize performance and minimize energy usage.
 - c. Sensor shall have 360-degree field of view.
 - d. Sensor shall incorporate non-volatile memory such that all settings and parameters are saved in protected memory.
 - e. Sensor shall have time delays from 10 to 30 minutes.
 - f. Sensor shall provide a visual means of indication that motion is being detected via an LED.
 - g. Sensors shall have readily accessible, user adjustable settings for time delay and sensitivity.
 - h. The sensor shall have an internal additional isolated relay with NO, NC and common outputs for use with HVAC control, data logging and other control options.
12. Wall Stations: Provide low voltage momentary push-button switches up to 6 button configurations to match requirements of lighting control within the room. Provide factory engraved labeling for individual push buttons. Provide in a color to match wiring devices and coverplates to match devices and plates in Wiring Devices (Section 26 2726). Wall station shall connect to the room controller via the room controller local network.

PART 3 - EXECUTION:

3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

- A. Install lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.
- B. Comply with Requirements of NEC, and applicable portions of NECA's 'Standard of Installation' pertaining to general electrical installation practices.
- C. Coordinate with other electrical work, including raceways, electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.
- D. Electrical Identification: Refer to Section 26 0553 for requirements.

3.2 FIELD QUALITY CONTROL:

- A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.
- B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.3 PRODUCT SUPPORT AND SERVICES:

- A. System Start-Up: Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:
 - 1. The control system has been fully installed in accordance with manufacturer's installation instructions.
 - 2. Low voltage wiring for overrides and sensors is completed.
 - 3. Accurate 'as-built' load schedules have been prepared for each lighting control panel.
 - 4. Proper notification of the impending start-up has been provided to the owner's representative.
 - 5. Programming of all switches, relays, groups of relays shall be completed by factory authorized technician, prior to final and training.
- B. Factory support: Factory telephone support shall be available at no cost to the owner during the warranty period for all systems. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll-free number for technical support.

3.4 WARRANTY:

- A. Manufacturer shall provide a one (1) year limited warranty on lighting control system. A ten (10) year limited warranty shall be provided on the lighting control relays.

3.5 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

3.6 TRAINING

- A. Provide four (4) hours of video taped training in two 2-hour sessions on the operation and use of the lighting control equipment, at job site, at no cost to the Owner.
- B. Specifically, for the DMX control system provide 5 hours of on-site training. The initial 2-hours of training to be video taped. Remaining hours of on-site training as needed by owner. Additional training available on an hourly to be determined rate/basis. These 5 hours are included in the contractor allowance for type O3 fixtures.

END OF SECTION 26 0943

SECTION 26 2200

TRANSFORMERS

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 work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of transformer work is indicated by drawings and schedules. Work includes complete installation and electrical connections.
- B. Types of transformers in this section include the following:
 - 1. Dry-type Distribution Transformers

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to installation and construction of electrical power/distribution transformers; with applicable portions of NEMA Std. Pub. Nos. TR1 and TR27; and with applicable ANSI/IEEE standards pertaining to power/distribution transformers.
- B. Comply with applicable portions of ANSI/UL 506; "Safety Standard for Specialty Transformers". Provide distribution transformers that have been UL listed and labeled.
- C. All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following ANSI/IEEE, NEMA, and Department of Energy standards.
 - 1. C57.12.00 – IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
 - 2. C57.12.28 – Pad-Mounted Equipment - Enclosure Integrity.
 - 3. C57.12.34 – IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVA and Smaller) - High Voltage: 34500GrdY/19920 Volts and Below; Low-Voltage: 480 Volt 2500 kVA and Smaller (issued in March 2005 - combines C57.12.22 and C57.12.26).
 - 4. C57.12.90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.
 - 5. C57.12.91 – Guide for Loading Mineral-Oil-Immersed Transformers.
 - 6. NEMA TR 1-1993 (R2000) – Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels for Liquid-Immersed Power Transformers.
 - 7. NEMA 260-1996 (2004) – Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas.
 - 8. 10 CFR Part 431 – Department of Energy – Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
 - 9. NEMA ST-20 - Dry-Type Transformers for General Applications
 - 10. NEMA TP-1-2002 – Standards for transformer energy efficiency.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

- A. MAINTENANCE STOCK FUSES: Refer to Section 26 0502 for requirements.

PART 2 -PRODUCTS

2.1 DRY -TYPE DISTRIBUTION TRANSFORMERS:

- A. GENERAL: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):
1. Acme Transformer Company
 2. GE/ABB
 3. Cutler Hammer Products, Eaton Corp.
 4. Federal Pacific
 5. Hevi-Duty Electric Div., General Signal Corp.
 6. Jefferson Electric
 7. Schneider Electric/Square D Co.
 8. Hammond Power Solutions
 9. Siemens Energy & Automation, Inc.
- C. DRY-TYPE DISTRIBUTION TRANSFORMERS (GENERAL PURPOSE):
1. Provide factory-assembled, general-purpose, air-cooled, copper wound dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated. Provide primary winding with minimum of 4 full capacity taps; each 2-1/2 percent, two above and two below full-rated voltage for de-energized tap-changing operation.
 2. Provide NEMA 3R enclosure for exterior installation.
 3. Insulate with 220-degree C. UL recognized insulation system for 80° degree C rise above 40o ambient at full load.
 4. Limit sound levels to the following (as determined by ANSI/NEMA standards):
 - a. 30-50 KVA 42 dB
 - b. 51-150 KVA 47 dB
 - c. 151-300 KVA 52 dB
 - d. 301-500 KVA 60 dB
 - e. 501-1000 KVA 64 dB
 5. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections. Equip terminal leads with connectors installed, suitable for copper or aluminum wiring. Cushion-mount transformer with vibration isolation supports. Provide transformers with ventilated, heavy gauge sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall and floor mounting as indicated.
 6. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 2.

Table 2 Percent Impedance Voltage (Dry-Type)	
KVA Rating (Secondary Voltage < 700 V)	Impedance
0 - 75	3.00 – 5.75%
112.5 - 225	4.00 - 5.75%
300 and above	5.00 - 5.75%

PART 3 – EXECUTION

3.1 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Connect transformer units to electrical wiring system; comply with requirements of other Division-26 sections.
- D. **MOUNTING:** Provide concrete pad under all floor mounted equipment and equipment mounted outside at grade. Secure equipment to pad. Refer to Section 26 0548 Electrical Seismic Control. Provide vertical and lateral support systems for all transformers that are supported from overhead structure. See drawings for support and attachment details. Provide neoprene vibration isolators at each anchor point.
- E. **GROUNDING:** Provide tightly fastened equipment grounding and bonding connections for transformers.
- F. **TESTING:** Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 2200

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SECTION 26 2413

SWITCHGEAR AND SWITCHBOARDS

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 work of this section.
- B. Division-26 Basic Materials and methods sections apply to work of this section except as otherwise indicated. See Section 262713 Service Entrance, for metering requirements. See Section 264313 for SPD requirements.

1.2 DESCRIPTION OF WORK:

- A. Extent of switchgear and switchboards is indicated by drawings and schedules.
- B. Types of switchgear and switchboards in this section include the following:
 - 1. AC Dead Front Switchboards (600V)

1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical switchgear and switchboards. Provide switchgear and switchboards that have been UL listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

- A. MAINTENANCE STOCK FUSES: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products of one of the following (for each type of switchgear and switchboard):
- B. AC DEAD FRONT SWITCHBOARDS (600V):
 - 1. Cutler-Hammer Products, Eaton Corp.
 - 2. GE/ABB
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D Co.

2.2 EQUIPMENT SECTIONS AND COMPONENTS:

- A. GENERAL: Except as otherwise indicated, provide switchgear and switchboards of types, sizes, characteristics, and ratings indicated, that comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation. See drawings and Section 262815. Series rated systems are not accepted.
- B. Overcurrent Protection Devices, for main and branch devices. Provide switchgear, switchboards, and overcurrent devices of one manufacturer.
- C. Provide each service entrance switchboard with surge protective device (SPD) mounted in a separate enclosure adjacent to the switchboard/switchgear. See Section 264313 for SPD unit requirements. Provide in-line fusing for each phase of the device, and wire in accordance with manufacturer's instructions, with conductor length not exceeding 18".

2.3 AC DEAD-FRONT SWITCHBOARDS (600V):

- A. Provide factory assembled, dead front, metal enclosed, floor standing, self supporting, group mounted, secondary power switch boards, of sizes, electrical ratings and characteristics indicated consisting of panel (vertical) units, and containing circuit breaker and fusible switch assemblies of quantities, ratings and types indicated. Provide copper main bus and connections to switching devices of sufficient capacity to limit rated continuous current operating temperature rise to UL standard; with main bus and tap connections silver-surfaced or tin-plated and tightly bolted for maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Prime and paint switchboard with manufacturer's standard finish and color. Equip units with built-in lifting eyes and yokes; provide individual panel (vertical) units, suitable for bolting together at project site, and constructed for the following environment:
 - 1. Installation: Indoors, NEMA Type 1.
- B. Limit height of upper most overcurrent device handle to 6'-2" to accommodate required 4" curb.

PART 3 - EXECUTION

3.1 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

- A. Install switchgear and switchboards where shown, in accordance with manufacturer's written instructions with recognized industry practices to ensure that switchgear and switchboards comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".
- B. Install all switchgear and switchboards on 4" high concrete curb. Install concrete wiring trench under switchgear and switchboards; 18" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench. Secure equipment to pad/trench. Refer to section 26 0548 Electrical Seismic Control.
- C. Arrange conductors within switchgear and switchboards in neat fashion, and secure with suitable ties.
- D. Tighten fuses, if any, in each switchgear and switchboard.
- E. Provide and install spare fuse cabinet in main electrical room.
- F. Electrical Identification: Refer to Section 260553 for requirements.

3.2 ADJUST AND CLEAN:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

- A. Prior to energization of switchgear and switchboards, check with ground resistance tester phase to phase and phase to ground insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, check switchgear and switchboards for electrical continuity of circuits, and for short circuits.
- C. Subsequent to wire and cable connections, energize switchgear and switchboard and demonstrate functioning in accordance with requirements.

END OF SECTION 26 2413

SECTION 26 2416

PANELBOARDS

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to panelboards specified herein.

1.2 DESCRIPTION OF WORK:

- A. The extent of panelboard and enclosure work, is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include lighting and appliance panelboards, and power distribution panelboards.

1.3 QUALITY ASSURANCE:

- A. Provide units that have been UL listed and labeled. Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC pertaining to installation of wiring and equipment in hazardous locations. Comply with NEMA Stds. Pub No. 250, "Enclosures for Electrical Equipment (1000 volt maximum). Pub No. 1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide of one of the following:
 - 1. Cutler Hammer Products, Eaton Corp.
 - 2. GE/ABB
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D Company

2.2 PANELBOARDS:

- A. GENERAL:
 - 1. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated. Equip with number of unit panelboard devices as required for complete installation. Fully equip "spaces" with hardware to receive breaker or switch of size indicated. Provide CU/AL rated lugs of proper size to accommodate conductors specified.
- B. POWER DISTRIBUTION PANELBOARDS:
 - 1. Provide dead-front safety type power distribution panelboards as indicated, with switching and protective devices in quantities, ratings, types and with arrangement shown. Equip with copper bus bars, full-sized neutral bus and ground bus. Provide fusible or circuit breaker branch and main devices as indicated. Series rated systems are not acceptable. See Section 262815, Overcurrent Protection Devices.

C. LIGHTING AND APPLIANCE PANELBOARDS:

1. Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangement shown. Provide bolt-on thermal magnetic type branch breakers. Where multiple breakers are indicated, provide with common trip handle. Series rated systems are not acceptable. Equip with copper bus bars, full-sized neutral bus, and ground bus.

D. PANELBOARD ENCLOSURES:

1. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage minimum 16-gage thickness. Provide door-in-door hinged fronts. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Provide enclosures fabricated by same manufacturer as overcurrent devices contained therein Bolt engraved plastic laminate labels indicating panel name and voltage on the interior and exterior of panelboards.
2. Provide floor to ceiling panel extensions for all surface mounted panels located outside of mechanical and electrical rooms.

E. FINISH:

1. Coat interior and exterior of surface with manufacturer's standard color; baked on enamel finish.

F. ELECTRICAL IDENTIFICATION:

1. Refer to Section 260553 for requirements.

PART 3 – EXECUTION

3.1 INSTALLATION OF PANELBOARDS:

A. GENERAL:

1. Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", in compliance with recognized industry practices to ensure products fulfill requirements.

B. MOUNTING:

1. Provide 4" high concrete curb under floor standing distribution panelboards.
2. Coordinate installation of panelboards and enclosures with cable and raceway installation work. Anchor enclosures firmly to walls and structural surfaces, ensuring they are permanently and mechanically secure. Arrange conductors neatly within enclosure, and secure with suitable nylon ties. Fill out panelboard's circuit directory card upon completion of installation work. Utilize actual final building room numbers, not architectural numbers used on drawings. Identify individual lighting circuits and individual receptacle circuits by room served. Label circuit breakers to identify location of subpanel or equipment supplied using room numbers and equipment names. Include room number with equipment circuit designations. All directories to be typewritten.

END OF SECTION 26 2416

SECTION 26 2713

SERVICE ENTRANCE

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 work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of service-entrance work is indicated by drawings and schedules.
- B. Switchboards, panels, disconnects, transformers, etc., used for service-entrance equipment are specified in applicable Division-26 sections, and are included as work of this section.
- C. Consult local utility relative to all costs for line extensions, connections, etc., and include all costs for bringing service to the facility in base bid. Confirm location of point of service before bidding.
- D. Provide labor and materials as required to accomplish power company metering in accordance with power company standards and requirements.
- E. Provide concrete pads of size and type required for service transformers. Verify location, size, openings, reinforcing requirements with local utility before beginning work. Comply with local utility code required clearance requirements.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of service-entrance equipment and accessories. Provide service-entrance equipment and accessories that are UL-listed and labeled, and equipment marked, "Suitable for use as Service Equipment".

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

- A. MAINTENANCE STOCK, FUSES: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 SERVICE - ENTRANCE EQUIPMENT:

- A. GENERAL: Provide service-entrance equipment and accessories, of types, sizes, ratings and electrical characteristics indicated, that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as herein specified.
- B. Provide each service entrance switchboard with Surge Protective Devices as required by Section 264313.

2.2 OVERCURRENT PROTECTIVE DEVICES:

- A. GENERAL: Provide overcurrent protective devices complying with Division-26 section "Overcurrent Protective Devices", and as indicated on drawings.

2.3 METERING:

- A. METER SOCKETS: Provide meter sockets that comply with requirements of local utility company supplying electrical power to service-entrance equipment of building project.

- B. METERS: Provide meters, current and potential transformers, selector switches, wiring, etc. for a complete metering system. Provide meter of same manufacturer as switchboard (equal to Square D Power Logic Circuit Monitor, Class 3020, Model CM-3250), integrally mounted in service equipment, completely wired with control power input. Provide capability for metering the following data:

<u>INSTANTANEOUS READINGS</u>	<u>DEMAND READINGS</u>
<u>RMS Current Values</u>	<u>Current Values</u>
Phase A Current	Average Demand Current Phase A
Phase B Current	Average Demand Current Phase B
Phase C Current	Average Demand current Phase C
3-Phase Average Current	Peak Demand Current Phase A
Apparent RMS Current	Peak Demand Current Phase B
RMS Voltage Values	Peak Demand Current Phase C
Phase A-B Voltage	Real Power Values
Phase B-C Voltage	Average Demand Real Power
Phase C-A Voltage	Predicted Demand Real Power
Phase A-N Voltage	Peak Demand Real Power
Phase B-N Voltage	Phase C-N Voltage
<u>Power Factor Values</u>	<u>Energy Readings</u>
Phase A Power Factor	-
Phase B Power Factor	Energy Accumulated
Phase C Power Factor	Reactive Energy Accumulated
3-Phase Total Power Factor	-
3-Phase Total Power Values	-
Real Power, 3-Phase Total	-
Reactive Power, 3-Phase Total	-
Apparent Power, 3-Phase Total	-
Frequency	-
Temperature	-

- C. Provide with integral display, selection keys, and indicating LEDs. For each instantaneous reading, provide a running maximum and minimum history in non-volatile memory, capable of externally operated reset. Provide "waveform capture" feature to allow subsequent analysis of actual current and voltage profile for harmonic distortion.

2.4 RACEWAYS AND CONDUCTORS:

- A. GENERAL: Provide raceways and conductors complying with applicable Division-26 Basic Materials and Methods sections.
- B. WALL AND FLOOR SEALS: Provide wall and floor seals complying with Division-26 Basic Materials and Methods section "Raceways".
- C. Fluidized thermal backfill (FTB): Provide fluidized thermal backfill (FTB) around service lateral conduits (Service Lateral: Conductors/conduits between RMP transformer and meter. See NEC Article 230) when there are seven or more conduits specified. FTB shall comply with requirements of Pacificorp material specification ZG071.

PART 3 – EXECUTION

3.1 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

- A. Install service-entrance equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.
- B. Coordinate with other work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work.
- C. Install all floor standing service equipment on 4" high concrete curb and bolt equipment to curb with 3/8" anchors at each corner and at intervals not to exceed 8' along perimeter. Install concrete wiring trench under floor standing equipment; 12" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

3.2 GROUNDING:

- A. Provide system and equipment grounding and bonding connections for service-entrance equipment and conductors, as required.

3.3 ADJUST AND CLEAN:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.4 FIELD QUALITY CONTROL:

- A. Upon completion of installation of service-entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION 26 2713

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SECTION 26 2726

WIRING DEVICES

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK:

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems that are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - 1. Receptacles
 - 2. Switches
 - 3. Dimmer controls
 - 4. Cord caps
 - 5. Cord connectors
 - 6. Flat Panel Display Wall Box

1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of electrical wiring devices. Provide electrical wiring devices that have been UL listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES:

A. GENERAL:

- 1. Provide factory-fabricated wiring devices, in types, and electrical ratings for applications indicated and complying with NEMA Stds. Pub No. WD 1.
- B. Provide wiring devices (of proper voltage rating) as follows:

	<u>RECEPTACLE</u>	<u>SWITCHES</u>			
<u>MFGR</u>		<u>1-POLE</u>	<u>3-WAY</u>	<u>4-WAY</u>	<u>W-PILOT</u>
Hubbell	HBL 5352	HBL 1221	HBL 1223	HBL 1224	HBL 1221-PL
Bryant	5352	1221	1223	1224	1221-PL
Pass Seymour	5352	20AC1	20AC3	20AC4	20AC1-RPL
Leviton	5362	1221	1223	1224	
Cooper	5352	1221	1273	1224	1221-PL

- C. Provide devices in colors selected by Architect. Provide red devices on all emergency circuits.
- D. TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) RECEPTACLES:
1. Provide TVSS receptacles having 4 series parallel 130V MOV's capable of a minimum of 140 joules suppression. Provide units with visual (and audible) surge status indicators to monitor condition of surge circuit; visual indicator to be "on" when power present and suppression circuit is fully functional. (Audible indicator shall sound a "beep" alarm approximately every 30 seconds if suppression circuit has been damaged.) Provide NEMA 5-20R, 20 amp, 125V receptacle of one of the following manufacturers:

<u>SPECIFICATION GRADE</u>	<u>MANUFACTURER</u>	
	<u>HUBBELL</u>	<u>PASS SEYMOUR</u>
Duplex Recept-Visual only	5350	5352 XXXSP
Duplex Recept-Visual/Audible	5352	5362 XXXSP
Single Recept-Visual only	5351	N/A
Duplex Recept-Isol Gnd, Visual/Audible	IG5352S	IG5362 XXXSP
Single Recept-Isol Gnd, Visual only	IG5351S	N/A
<u>HOSPITAL GRADE</u>	<u>HUBBELL</u>	<u>PASS SEYMOUR</u>
Duplex Recept-Visual/Audible	8300HS	8300 XXXSP
Single Recept-Visual only	8310HS	N/A
Duplex Recept-Isol Gnd, Visual/Audible	IG8300HS	IG8300 XXXSP
Single Recept-Isol Gnd, Visual only	IG8310HS	N/A

2. Color of devices selected by Architect. Provide red devices on all emergency circuits.

E. GROUND-FAULT INTERRUPTER:

1. Provide general-duty, duplex receptacle, ground-fault circuit interrupters; feed-thru types, capable of protecting connected downstream receptacles on single circuit; grounding type UL-rated Class A, Group A, 20-amperes rating; 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; color as selected by Architect. Provide Hospital grade where required elsewhere by specification or drawings. Provide units of one of the following:
 - a. P&S/Sierra
 - b. Hubbell
 - c. Leviton
 - d. Square D

F. USB RECEPTACLE

1. Provide duplex receptacle with two (2) USB 3.0 amps, 5VDC, 2.0 Type A charging ports.
2. Provide products of one of the following:

- a. Bryant – USB20-X
- b. Cooper – TR7736-X
- c. Hubbell – USB20X2-X
- d. Legrand – TR5362USB-X
- e. Leviton – T5832-X

G. TAMPER RESISTANT RECEPTACLES:

- 1. Provide tamper resistant receptacles in the following areas; Dwelling units, guest rooms and guest suites, child care facilities, pre-school and elementary education facilities, business offices, corridors, waiting rooms and the like in Clinics, medical/dental offices and outpatient facilities, assembly occupancies and Dormitories.
- 2. Provide products of one of the following:
 - a. Leviton-TWR20-X
 - b. Hubbell – BR20XTR
 - c. Pass Seymour – TR63X
 - d. Cooper – TR5362

H. WEATHER-RESISTANT RECEPTACLES

- 1. Provide weather-resistant receptacles in outdoor locations such as under roofed open porches, canopies, marquees, etc.
- 2. Provide products of one of the following:
 - a. Pass & Seymour 2095TRWRXXX.
 - b. Hubbell GFTR20XX

I. CORD CAPS AND CONNECTORS:

- 1. Provide 3, 4 and 5-wire grounding, cap plugs, and connectors of ampere and voltage rating required, for final equipment, and as indicated otherwise on drawings.
- 2. Provide products of one of the following:
 - a. Cooper
 - b. General Electric
 - c. Hubbell
 - d. Leviton
 - e. P&S

2.2 WIRING DEVICE ACCESSORIES:

A. WALL PLATES:

- 1. Provide coverplates for wiring devices; plate color to match attached wiring devices. Provide stainless steel coverplates in all finished areas. Provide galvanized steel plates in unfinished areas. Provide blank coverplates for all empty outlet boxes.

B. WEATHER-PROTECTING DEVICE ENCLOSURES:

- 1. Where required for compliance with NEC 406-8 (receptacles installed outdoors for use other than with portable tools or equipment), provide weather-tight device

covers that provide complete protection with the cord and cap inserted into the wiring device. Provide units that mount on either single or double gang devices.

2. Coordinate with architect and provide products of one of the following for In Box Horizontal for brick and cast stone:
 - a. Arlington Industries
 - i. DSHB1C Clear Cover
 - ii. DSHB1W White Cover
 - iii. DSHB1BR Brown Cover
 - iv. DSHB1BRC Brown Clear Cover
3. Coordinate with the architect and provide products of one of the following for In Box Vertical or Horizontal for Stucco and Metal Sidings:
 - a. Arlington Industries
 - i. DSBVM1C Clear Cover
 - ii. DSBVM1W White Cover
 - iii. DSBHM1C Clear Cover
 - iv. DSBHM1W White Cover
4. Provide products of one of the following for roof mounted installations:
 - a. Intermatic WP1020 or WP1030
 - b. P&S WIUC10C or WIUC20c

2.3 FLAT PANEL DISPLAY WALL BOX:

- A. Provide a factory assembled display wall box made of 14 gauge steel. Wall box shall have provisions for a UL Listed single gang box for mounting of duplex receptacle and additional back box with a minimum of (1) 1 ¼" conduit opening to allow for low voltage terminations. Coordinate low voltage plate configuration with drawings. Provide device manufactured by one of the following:
 1. FSR Metal Products – PWB-320
 2. Chief Manufacturing – PAC 526FCW
 3. Wiremold – EFSB4

PART 3 – EXECUTION

3.1 GENERAL

- A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work. Install devices in boxes such that front of device is flush and square with coverplate. Drawings are small scale and, unless dimensioned, indicate approximate locations only of outlets, devices, equipment, etc. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate with other work. Verify all dimensioned items on job site. Consult architectural cabinet, millwork, and equipment shop drawings before beginning rough-in of electrical work. Adjust locations of all electrical outlets as required to accommodate work in area, and to avoid conflicts with wainscot, back splash, tackboards, and other items.

- C. Provide receptacles in surface raceway at 24' on center unless indicated otherwise.
- D. Install wiring devices only in electrical boxes that are clean; free from excess building materials, dirt, and debris.
- E. Install blank plates on all boxes without devices.
- F. Delay installation of wiring devices until wiring work and painting is completed. Provide separate neutral conductor from panel to each GFI receptacle.
- G. Install GFI receptacles for all receptacles installed in the following locations:
 - 1. Restrooms, locker rooms, kitchens, within 6 feet of any sink, or when serving vending machines.
 - 2. Indoor wet locations, non-dwelling garages, Zamboni parking area, elevator rooms and pits.
 - 3. Outdoors, and on rooftops.
 - 4. Dwelling unit garages, crawlspaces and unfinished basements, accessory buildings, boathouses, and receptacles for boat hoists.
- H. Provide GFCI breakers for electric drinking fountains
- I. Where light switches or wall box dimmers are specified, provide a separate neutral for each phase of the branch circuits that switches or dimmers are connected.
- J. Electrical Identification: Refer to Section 260553 for requirements.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

- A. At time of substantial completion, replace those items, that have been damaged, including those stained, burned and scored.

3.3 GROUNDING:

- A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated.

3.4 TESTING:

- A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

END OF SECTION 26 2726

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SECTION 26 2815

OVERCURRENT PROTECTIVE DEVICES

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to overcurrent protective devices specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of overcurrent protective device work is indicated by drawings and schedules and specified herein. Overcurrent protective devices specified herein are for installation as individual components in separate enclosures; and for installation as integral components of switchboard and panelboards. See Section 262413, Switchgear and Switchboards, and Section 262416, Panelboards.
- B. Types of overcurrent protective devices in this section include the following for operation at 600 Volts and below:
 - 1. Molded case thermal circuit breakers
 - 2. Molded case solid-state circuit breakers
 - 3. Insulated case circuit breakers
 - 4. Fuses
- C. Refer to other Division-26 sections for cable/wire and connector work required in conjunction with overcurrent protective devices.

1.3 QUALITY ASSURANCE

- A. Comply with NEC requirements and NEMA and ANSI standards as applicable to construction and installation of overcurrent devices.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products of one of the following (main and branch device manufacturer must be same as panelboard and/or switchboard manufacturer):
- B. CIRCUIT BREAKERS AND FUSIBLE SWITCHES:
 - 1. Cutler Hammer Products, Eaton Corp.
 - 2. GE/ABB
 - 3. Square D Co.
 - 4. Siemens Energy and Automation
- C. MOLDED CASE THERMAL TRIP CIRCUIT BREAKERS:
 - 1. Provide factory-assembled, molded case circuit breaker for power distribution panelboards and switchboards; and for individual mounting, as indicated. Provide breakers of amperage, voltage, and RMS interrupting rating shown, with

permanent thermal trip and adjustable instantaneous magnetic trip in each pole. Series rated systems are not acceptable. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with mechanical screw type removable connector lugs, AL/CU rated, of proper size to accommodate conductors specified.

2. Circuit breakers 15 amps through 599 amps shall be molded case thermal trip circuit breakers.

D. MOLDED CASE SOLID-STATE CIRCUIT BREAKERS:

1. Provide factory-assembled, molded case solid-state circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, and with solid-state trip mechanisms. Breakers shall be UL listed for application at 100% of their continuous ampere rating.
2. Circuit breakers 600 amps through 1199 amps shall be molded case solid-state circuit breakers.
3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.

E. INSULATED CASE CIRCUIT BREAKERS

1. Provide factory-assembled, insulated case circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, with solid-state trip mechanisms and with manual spring charging mechanism. Breakers shall be UL listed for application at 100% of their continuous ampere rating.
2. Circuit breakers 1200 amps and larger shall be insulated case circuit breakers.
3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long-time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.
4. On service disconnect breakers where phase to ground voltage exceeds 150V and the breaker is capable of being set at or over 1000A (and also where GFP protection is indicated on the one line diagram for downstream breakers), the solid-state trip mechanism shall also include the following:
 - a. Adjustable ground fault pick up and adjustable ground fault time delay, and ground fault test button.
 - b. Over/under voltage trip
 - c. Current imbalance trip
5. Provide an energy-reducing maintenance switch with local, lit status indicator to allow for a reduction of the instantaneous pickup and instantaneous delay settings for use during maintenance. Device shall mount in face of dead-front. The switch shall be provided by the same manufacturer as the circuit breaker.
6. Include integral phase failure (single-phasing) protection where phase failure (PF) is indicated on the one line diagram

F. PHASE FAILURE PROTECTION:

1. Provide phase failure protection on overcurrent protective devices, by means of a single-phase, dead phase, reverse phase relay (Taylor Electronics Md1 PNRD). Provide relay to operate shunt trip or capacitor trip as required to open

overcurrent protective device upon malfunction. Provide relay with adjustable time delay.

G. GROUND FAULT PROTECTION:

1. Provide ground fault sensing and relaying equipment on all overcurrent protective devices where phase to ground voltage is in excess of 150 volts and the overcurrent protection device is capable of being set at or over 1000 amps. Provide ground fault sensing and relaying equipment on other devices as indicated.
2. Provide zero sequence current sensors for overcurrent protective devices; inputs compatible with relay. Construct sensor frame so it can be opened to prevent removal or installation around conductors without disturbing conductors. Provide test winding in sensor for testing operation of GFP unit including sensor pick-up relay, and circuit protection device operation.
3. Provide solid-state ground-fault relay, that requires no external source of electrical power, drawing energy to operate GFP system directly from output of current sensor. Construct with adjustable pick-up current sensitivity for GF current from 200 to 1200 amperes, with calibrated dial to show pick-up point settings. Provide factory-set time delay of 1.5 seconds and protection that precludes tampering with setting after installation.
4. Provide monitor panel capable of indicating relay operation, and provide means for testing system with or without interruption of service. Construct so GF system can not be left in an inactive or OFF state. Provide indicator lamps and TEST and RESET control switches.
5. MANUFACTURER: Subject to compliance with requirements, provide ground-fault sensing and relaying equipment of one of the following:
 - a. GE/ABB
 - b. Brown Boveri Electric, Inc.
 - c. HI-Z Corporation
 - d. Pringle Electric Mfg. Co.
 - e. Square D Co.

2.2 FUSES

- A. GENERAL: Except as otherwise indicated, provided fuses of type, sizes and ratings and electrical characteristics of a single manufacturer as follows. Provide fuses labeled UL Class L or UL Class R, current limiting and rated for up to 200,000 amperes. Provide Buss KAZ signal activating fuses where required elsewhere in specification.
- B. Where fuses are shown feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing; adjust fuse size and type as necessary to comply with manufacturer's recommendation.
- C. Provide and install spare fuse cabinet in main electrical room.
- D. MAIN SERVICE AND FEEDER CIRCUITS: For fuse ratings over 600 amperes provide UL Class L Fuses (KRP-C, or A4BQ or LCL or KLPC). For fuse ratings up to 600 amperes, provide UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R or NCCR, SCLR or KLN-R, KLS-R). If fuse directly feeds motors, transformers or other inductive load provide UL RK5 time delay (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECS-R or FLN-R, FLS-R).
- E. BRANCH CIRCUITS: For motor circuits, transformer circuits, or other inductive loads, provide UL Class RK5 (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECN-S or FLN-R, FLS-A). For other circuits, provide UL Class RK1, (KTN-R, KTS-R OR A2K-R, A6K-R or NCLR, SCLR OR KLN-R, KLSR).

- F. MANUFACTURER: Subject to compliance with requirements, provide fuses of one of the following:
1. Bussman Mfg. Co.
 2. Mersen (Ferraz Shawmut)
 3. Reliance Fuse Div./Brush Fuse Inc.
 4. Littlefuse, Inc.

PART 3 – EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

- A. Install overcurrent protective devices as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.
- B. Coordinate with work as necessary to interface installations of overcurrent protective devices with other work.
- C. Install fuses in overcurrent protective devices. For motor circuits, fuse sizes shown on drawings are for general guidance only. Size fuses in accordance with fuse manufacturer's recommendation for given motor nameplate ampere rating. Test operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) as required to provide nuisance free tripping. Adjust fuse size properly for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times. Include all costs in bid.
- D. After the switchgear is energized and just prior to Substantial Completion, the contractor shall ensure that the field-adjustable circuit breakers and solid-state circuit breakers and associated trip mechanisms have been set to the appropriate settings as recommended by the equipment Manufacturer (or as recommended by the electrical contractor's Protective Device Study if section 260573 has been included in the project). Time-current trip curves and trip setting information as was required in the Submittal portion of this specification shall be made available by the contractor at this time.
- E. Field test all ground fault protective devices for proper operation; test to be performed by representative of the manufacturer. Include verification of complete time current trip characteristics.
- F. Electrical Identification: Refer to Section 260553 for requirements.

3.2 FIELD QUALITY CONTROL

- A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION 26 2815

SECTION 26 2913

MOTOR STARTERS

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 work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of Division-26 sections making reference to motor starters specified herein.

1.2 DESCRIPTION OF WORK:

- A. Extent of motor starter work is indicated by drawings and schedules.
- B. Types of motor starters in this section include the following:
 - 1. AC Fraction Horsepower Manual Starters
 - 2. AC Line Voltage Manual Starters
 - 3. AC Non-Reversing Magnetic Starters
 - 4. AC Combination Non-Reversing Magnetic Starters

1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA Standards as applicable to wiring methods, construction and installation of motor starters. Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units that have been UL-listed and labeled.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

- A. Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):
 - 1. Allen-Bradley Co.
 - 2. Appleton Electric Co.
 - 3. Crouse-Hinds Co.
 - 4. Eaton Corp., Cutler Hammer Products
 - 5. GE/ABB
 - 6. Siemens Energy & Automation, Inc.
 - 7. Square D Co.
- B. MAINTENANCE STOCK, FUSES: Refer to Section 26 0502 for requirements.

2.2 MOTOR STARTERS:

- A. GENERAL: Except as otherwise indicated, provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated that comply with manufacturer's standard materials, design and construction in accordance with published information and as required for complete installations.

- B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized to actual running full load current, not to motor plate current. Size heaters for mechanical equipment after air and water balancing have been completed.
- C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide manual, single-phase, 1 and 2 pole, 300 volt AC max, fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with one piece thermal overload relay with field adjustment capability of plus or minus 10 percent of nominal overload heater rating; for protection of AC motors of 1 HP and less. (For manually controlled motors in excess of 1 HP, see Line Voltage Manual Starters specified herein). Provide starter with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with lock-off toggle operated handle. Mount surface units in NEMA 1 enclosures, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location unless noted otherwise. Provide flush mounted units with coverplate to match wiring device coverplates.
- D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide line voltage manual starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt AC max; equip with pushbutton operator, low voltage protection feature, and green pilot light. Provide starters with trip free mechanism such that contacts will open under load and remain open until thermal element has cooled, and unit is reset. Mount surface units in NEMA 1 enclosure, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Provide overlapping trim for flush mounted units.
- E. AC NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8536): Provide line voltage magnetic starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt max, with thermal overload protection in all phases and inherent under voltage release. Equip units with holding contact, 2 normally open, and 2 normally closed auxiliary contacts, unless noted otherwise. Provide fused control transformer in each starter and 120V control coil. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide NEMA 1 enclosure unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Equip all spare starters complete with items as specified herein.
- F. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8539): Provide line voltage combination starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volts max with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with motor circuit protector. Provide motor circuit protector, instantaneous trip circuit breaker as indicated and adjust to comply with manufacturer's recommendations. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control center as indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise. Provide NEMA 1 enclosures unless otherwise indicated.
- G. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8538): Provide line voltage combination starters, of types, ratings, and electrical characteristics; 2 or 3 pole, 600 volt maximum with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with fusible disconnect switch. Provide quick-make, quick-break, disconnect for NEMA sizes 1, 2, 3, and 4; and visible blade, automatic circuit interrupters with push-to-trip feature and separate fuse clips for larger NEMA sizes. Fuse all starters with dual-element (time-delay) fuses equal to Bussman FRN/FRS-R. Equip disconnect switch with Class R rejection fuse kits. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control centers as indicated. Provide NEMA 1 enclosures unless otherwise indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS:

- A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Install fuses in fusible disconnects, if any. Mount chart inside each starter indicating heater type, size, and ampere ratings available.
- C. Electrical Identification: Refer to Section 260553 for requirements.

3.2 ADJUST AND CLEAN:

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

- A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 26 2913

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SECTION 26 4313

SURGE PROTECTIVE DEVICES (SPD)

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 work of this section.
- B. Division 26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of SPD's work is indicated by drawings, schedules and specified herein. Work includes complete installation, electrical connections, testing, and commissioning.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC, NEMA and IEEE Standards as applicable to wiring methods, construction and installation of SPD's. Comply with applicable requirements of ANSI/IEEE C62.11, C62.41.2 and C62.45; NFPA 70 285 (Type 2), 75, and 78; and ANSI/UL 1449 4th edition. Provide complete packaged units that have been listed and labeled by Underwriters Laboratory. UL surge ratings (UL 1449) must be permanently affixed to the SPD's device.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS:

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products manufactured by one of the following as indicated by "Location Category" herein.
 - 1. Advanced Protection Technologies Inc.
 - 2. Current Technology Inc.
 - 3. Cutler Hammer, Inc.
 - 4. L.E.A. International
 - 5. Emerson Network Power Surge Protection Inc.
 - 6. United Power Corporation
 - 7. GE
 - 8. Eaton
 - 9. Surgelogic (Square D)
 - 10. Siemens Energy & Automation, Inc.

2.2 GENERAL:

- A. Except as otherwise indicated, provide high energy surge protective devices, with high frequency line noise filtering, suitable for application in Category A, B, and C environments as indicated. Provide types, sizes, ratings and electrical characteristics indicated that comply with manufacturer's standard materials, design, and construction in accordance with published information and as required for a complete installation.

2.3 VOLTAGE SURGE SUPPRESSION – GENERAL:

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Configuration	Protection Modes			
	L-N	L-G	L-L	N-G
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

5. Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
6. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral

monitoring options:

- a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
 - i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
 - ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
- b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
- c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
- d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection

- a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged

together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.
8. Safety Requirements
 - a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
 - b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.4 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Refer to table below for category type.

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

- C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:
- D. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.5 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
 - 1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 - 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 - 3. The panelboard shall be capable of re-energizing upon removal of the SPD.
 - 4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
 - 5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
 - 6. The SPD shall be of the same manufacturer as the panelboard.
 - 7. The complete panelboard including the SPD shall be UL67 listed.
- B. Switchgear, Switchboard, MCC and Busway Requirements
 - 1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
 - 2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway
 - 3. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer
 - 4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
 - 5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
 - 6. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
 - 7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.6 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 - 1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
 - 2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to

provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure.

3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPD's as indicated in accordance with manufacturers recommendations and as necessary to meet requirements. Install with conductors of minimum length practicable, but in no case exceeding 30" in length; minimum conductor size - #8 AWG copper.
- B. Install conductors in straight runs with a minimum of turns or bends (minimum bend radius to be 90 degrees). Do not splice phase or ground conductors in SPD's circuit. Torque all conductor terminations in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL:

- A. Upon completion of installation of equipment, energize and demonstrate capability and compliance with requirements. Remove malfunctioning units, replace with new units and proceed with retesting.

END OF SECTION 26 4313

SECTION 26 5100

INTERIOR AND EXTERIOR BUILDING LIGHTING

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 work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Types of lighting fixtures in this section are indicated by schedule and include the following:
 - 1. High-Intensity-Discharge (HID)
 - 2. Fluorescent
 - 3. Incandescent/Halogen
 - 4. LED (Light Emitting Diode)

1.3 QUALITY ASSURANCE:

- A. Comply with NEC, NEMA and ANSI 132,1 as applicable to installation and construction of lighting fixtures. Provide lighting fixtures that have been UL-listed and labeled.
- B. Components and fixtures shall be listed and approved for the intended use by a National Recognized Testing Laboratory (NRTL) including: UL, ETL, and CSA or equivalent
- C. All led products shall comply with the latest version of Illuminating Engineer Society (IES) publications LM-79 and LM-80.
- D. All fixtures shall be approved and listed on at least one of these 3 Qualified Fixture Lists; Energy Star, Design Lighting Consortium (DLC), or Lighting Design Lab.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products of one of the following (for each type of fixture):
 - 1. LED:
 - a. Cree
 - b. Nichia
 - c. Samsung
 - d. Philips Lumiled
 - e. Osram
 - f. Xicato

2.2 INTERIOR AND EXTERIOR LIGHTING FIXTURES:

A. GENERAL:

1. Provide lighting fixtures, of sizes, types and ratings indicated complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, LED drivers, starters, and wiring. Label each fixture with manufacturer's name and catalog number. Provide all enclosed fixtures with positive latch mechanisms; spring tension clips not acceptable. Provide all exterior fixtures with damp or wet location label as required by application.

B. SUPPORT REQUIREMENTS:

1. Provide all pendant and stem hung fixtures with flexible ball joint hangers at all points of support. Equip hooks used to hang fixtures with safety latches. Provide all detachable fixture parts, luminous ceiling accessories, louvers, diffusers, lenses, and reflectors with locking catches, screws, safety chain, or safety cable.

C. LIGHT EMITTING DIODE (LED) LUMINAIRES:

1. LED luminaires that can be serviced in place shall have a disconnecting means internal to the luminaires to disconnect simultaneously from the source of supply all conductors of the driver, including the grounded conductor. Disconnects shall not be required under the following exceptions:
 - a. Luminaires located in hazardous locations.
 - b. Luminaires used for egress lighting.
 - c. Cord-and-plug luminaires.
 - d. In industrial establishments with restricted public access where conditions of maintenance and supervision ensure that only qualified persons service the installation.
 - e. Where more than one luminaire is installed in a space and where disconnecting the supply conductors to the luminaire will not leave the space in total darkness.
 - f. Provide LED luminaires which are tested in accordance with IES LM-79, diodes tested in accordance with IES LM-80, and provide a minimum R9 rating of ≥ 50 (unless specified differently), a CRI rating of $\geq$ than 80 and L70 (6K) = 50,000 hours (IES TM-21). Provide with 0-10V dimming drivers as standard.
 - g. The fixture manufacturer(s) shall warrant the luminaires, in their entirety, to be free from defects in material or workmanship for at least 5 years from date of manufacture. Provide warranty in accordance with other sections of this specification and include a certificate of warranty from the fixture manufacturer with extended warranty information and proper forms and procedure description.

D. DIFFUSERS:

1. Where plastic diffusers are specified, provide 100 percent virgin acrylic compound; minimum thickness, .125 inches.

PART 3 - EXECUTION

3.1 INSTALLATION OF LIGHTING FIXTURES

- A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standards of Installation", NEMA standards, and with recognized industry practices to ensure that

lighting fixtures fulfill requirements.

- B. Coordinate with other work as appropriate to properly interface installation of lighting fixtures with other work. Consult architectural reflected ceiling plan for exact location of all lighting fixtures.
- C. Provide all necessary supports, brackets, and miscellaneous equipment for mounting of fixtures. Support all ceiling mounted fixtures from the building structure; independent of the ceiling system, unless noted. Support each recessed fixture (fluorescent incandescent, and/or HID) from the building structure with #12 ga. steel wire attached to each corner (in addition to supports normally provided for attachment to the ceiling system). Provide backing supports above (or behind) sheetrock, plaster and similar ceiling and wall materials. Support surface mounted ceiling fixtures from channel. Support ceiling mounted outlet boxes independent of the raceway system, and capable of supporting 200 pounds. Feed each recessed fixture directly from an outlet box with flex conduit as required; do not loop from fixture to fixture. See plans for additional details.
- D. **FIXTURE WHIPS:**
 - 1. Provide each lay-in light fixture with at least 36" (Not to exceed 72") of 3/8" steel flexible conduit.
 - 2. Within spaces utilizing 0-10v control schemes ie: Room Controllers, the fixture whip shall be comprised of a MC-PCS Cable (see Section 26 0532 Conduit raceways) with at least 36" and not to exceed 72" in length located above removable grid ceilings.
- E. Coordinate lighting in mechanical room with duct and equipment locations to avoid obstruction of illumination.
- F. Provide gypsum board protection as required, (acceptable to fire official having jurisdiction) to ensure fire rating of each ceiling that the fixtures are installed in.
- G. **COORDINATION MEETINGS:**
 - 1. Meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate each light fixture mounting condition with ceiling type. During second meeting, coordinate fixture layout in each area.
 - 2. Meet at least once with the mechanical installer prior to fabrication and installation of duct work. Coordinate depth and location of all fixtures and duct work in all areas.
- H. **ADJUST AND CLEAN:**
 - 1. Clean lighting fixtures of dirt and debris upon completion of installation.
 - 2. Protect installed fixtures from damage during remainder of construction period. Repair all nicks and scratches to appearance of original finish.
- I. **SPARE PARTS:** Refer to Section 26 0502 for requirements.

3.2 FIELD QUALITY CONTROL:

- A. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements.
- B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.
- C. At the time of Substantial Completion, replace lamps in interior lighting fixtures that are observed to be noticeably dimmed after the Contractor's use and testing, as judged by Architect/Engineer.
- D. **GROUNDING:**

1. Provide equipment grounding connections for each lighting fixture.

END OF SECTION 26 5100

SECTION 26 5600

EXTERIOR AREA LIGHTING

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 work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Types of lighting fixtures in this section are indicated by schedule and include the following:
 - 1. LED (Light Emitting Diode)
- B. Excavation and backfilling for exterior area lighting poles, standards and foundations are specified in applicable Division-26 general provision sections.
- C. Concrete for embedding poles, and for pole foundations and footings is specified in other sections of specification. Provide pole bases under this section of the specification.
- D. Refer to other Division-26 sections for cable, wire and connectors required in connection with exterior area lighting poles and standards.

1.3 QUALITY ASSURANCE:

- A. Comply with NEC, NEMA and ANSI/IES requirements as applicable to location and installation of lighting poles and standards. Provide lighting components and fittings that are UL-listed and labeled.
- B. Comply with other portions of specification as applicable for forming, splicing, and curing of concrete bases provided under this section.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER: Subject to compliance with requirements, provide products as scheduled on drawings.

- A. FUSES: Refer to Section 26 0502 for requirements.
- B. CONCRETE: 3000 psi Class.
- C. LIGHT FIXTURE POLES: Provide light fixture poles that comply with the following minimum requirements.
 - 1. The pole shaft constructed of seamless aluminum alloy per requirements of ASTM B221. Include a flush covered hand hole in each pole with finish hardware. Provide a permanent marking with the manufacturer name inside the hand hole for easy recognition.
 - 2. Provide aluminum alloy anchor base welded to the pole shaft. Welding must comply with AWS Specification D1.2, Structural Welding Code – Aluminum. The complete assembly must be heat-treated to a T6 temper.
 - 3. Provide super durable thermosetting polyester power coat paint, a minimum of 1.5 mils thick along the entire length of the pole.

4. Include aluminum nut covers for a "Shoe Base" trim.
5. Provide a 10-year minimum guarantee, which covers the pole structure and paint.
6. Provide vibration dampening in poles.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install area lighting units as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards and with recognized industry practices to ensure that lighting units fulfill requirements.
- B. Coordinate with other work as necessary to properly interface installation of roadway and parking area lighting with other work.
- C. Comply with NEC 300-5 (or State of Utah requirement, whichever is most stringent), for raceway burial depth.
- D. Mount lighting units on concrete bases as indicated, complete with anchor bolts and reinforcing bars. Coordinate proper size and location of all bases as required to ensure proper installation. Provide 3000 psi class concrete; hand rub all exposed concrete to uniform, smooth finish.
- E. Deliver poles to job site with factory finish paint.
- F. Set poles and standards plumb. Support adequately during backfilling, or anchoring to foundations.
- G. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling.
- H. Provide Bussman HEB fuseholder (or Littelfuse LEB-XX-S) with "breakaway" receptacles in all conductors running to the top of each pole. Locate fuseholder at hand hole or in base junction box as applicable. Provide KTK fuses in each phase conductor, sized 1.5 times maximum full load current of ballasts served by each conductor. Do not exceed rating of circuit overcurrent protective device. Provide fuse blanks in neutral conductors. Make up all other splices in pole or pole base using Scotchcast 400 Resin for watertight connection.

3.2 GROUNDING:

- A. Provide equipment grounding connections for each lighting unit installation.

END OF SECTION 26 5600

SECTION 27 1500

TELEPHONE/DATA SYSTEMS

PART 1 – GENERAL

1.1 SCOPE OF DOCUMENT:

- A. The following are project specifications that all cabling systems must adhere to. These specifications apply to all installers (hereinafter referred to as “the Contractor”) for all sites, that require, standards-compliant structured cabling systems and shall be used for all the installation, testing, and acceptance of the information transport systems as described in the attached specifications. Prices quoted of the installation facilities shall be all-inclusive and represent a complete installation at such sites as prescribed in this specification and contract documents. The Contractor shall be solely responsible for all parts, labor, testing, acceptance and all other associated processes and physical apparatus necessary to turn-over a completed system fully warranted and operational for acceptance by the Customer. Final acceptance of the installation shall be in writing by the Architect and Engineer.
- B. In all instances where Standards are cited, it is assumed Installer will have familiarity with and implicitly follow the recommendations of the most current version of the Standard referenced at the time of installation. Compliance with most current Standards is the sole responsibility of the Contractor.

1.2 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-7 Firestopping, apply to work of this section.
- C. Division-26 Basic Materials and Methods sections apply to work specified in this section.
- D. Refer to and coordinate with specification 27 4100 for any audiovisual equipment requiring UTP based category and/or optical fiber cabling and connectivity. Division 27 1500 shall provide installation and execution requirements for all category and/or optical fiber cabling and connectivity required within the audiovisual system

1.3 SCOPE OF WORK:

- A. The extent of telephone/data system work is indicated by drawings and is hereby defined to include, but not be limited to racks, cabinets, patch panels, cables, raceway, outlet boxes, device plates, backboard, and grounding. Contractor is responsible for installation of all specified and unspecified necessary and miscellaneous items required for delivery of a complete and functional data cabling and device system.
- B. Contractor shall provide complete cable and outlet system as indicated on the drawings and described herein. Work shall include all associated infrastructure transmission components and support appliances including, but not be limited to cable, jacks, terminal blocks, racks, cabinets, wire management, labeling, transient voltage surge suppression, patch cords, telecommunications grounding system and all terminations as specified herein.
- C. Contractor shall provide system testing as described herein using up-to-date and industry accepted Level IIIe, IV, V test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1. All testers used shall be factory calibrated within one year of use with references set daily prior to testing.
- D. All active equipment (electronics) will be owner furnished and owner installed.

- E. Contractor shall be solely responsible for all parts, labor, testing, documentation and all other associated processes and physical apparatus necessary to turn-over the completed system fully warranted and operational for acceptance by Owner and Engineer.
- F. Contractor shall provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents.
- G. Copper solution must match optical fiber solution and be provided by the same manufacturer. No two separate warranties are acceptable for the copper connectivity and optical fiber connectivity.
- H. Contractor shall provide 1-1" EMT conduit from telecommunications outlet/connector to accessible ceiling space, then utilize non-continuous cable support devices to EF/ER/TR/TE.

1.4 CONTRACTOR QUALIFICATIONS

- A. The contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to voice and data network systems. The Contractor shall at a minimum possess the following qualifications:
 - 1. Must have at a minimum (1) RCDD certified individual employed full time at the time of bidding and throughout entire project. **PROVIDE PROOF OF RCDD CERTIFICATION IMMEDIATELY UPON JOB AWARD.**
 - 2. Approved and certified by connectivity manufacturer. Provide proof of certification immediately upon job award.
 - 3. BICSI Certified Installers or equivalent.
 - 4. Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
 - 5. Have a minimum of 5 years in the communications structured cabling business and be able to provide three owner references for the type of installation described in this specification for projects within the last 18 months.
 - 6. Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must own not rent a light meter or fiber test adapter head, and OTDR and shall be factory certified by the manufacturer of the products being installed.
 - 7. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
 - 8. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.
 - 9. Be factory certified by the manufacturer used in installation of all transmission components of all copper and fiber links and able to provide the manufacturer warranty.

1.5 QUALITY ASSURANCE

- A. Required Pre-Telecommunications Construction Meeting with Communications Engineer: Electrical contractor/representative AND Communications Contractor will be required to attend a pre-communications construction meeting (approximately 30-60 minutes) with Communications representative in the electrical engineer's office prior to communications construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to specifications, plans and site visits for both rough and finish electrical work.
- B. Owner IT Contact:

1. **Francis Xavier Lilly, flilly@millcreek.us, 801-214-2752**
- C. BNA IT Contact:
 1. **Rich Bradley; rich@bnaconsulting.com, 801-532-2196**
 2. **Son Nguyen; snguyen@bnaconsulting.com, 801-532-2196**

1.6 APPLICABLE CODES AND STANDARDS

- A. Contractor is responsible for compliance with all applicable portions of the NEC code as to type of products used and installation of components. All materials used shall be products and materials that have been UL-listed and labeled. All installed products shall comply with applicable NEMA standards for low loss extended frequency cable.
- B. In addition, installation shall adhere to the following Standards:
 1. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises, or most recent edition at the time of installation
 2. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Cabling Standards, or most recent edition at the time of installation
 3. ANSI/TIA-568-C.2 - Balance Twisted Pair Communications and Components Standards, or most recent edition at the time of installation
 4. ANSI/TIA -942 -Telecommunications Infrastructure for Data Centers, or most recent edition at the time of installation
 5. TIA-569-B - Commercial Building Standard for Telecom Pathways and Spaces, or most recent edition at the time of installation
 6. ANSI/TIA-606-A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, or most recent edition at the time of installation
 7. ANSI/NECA/BICSI-607 - Commercial Building Grounding/Bonding Requirements, or most recent edition at the time of installation
 8. ANSI/TIA 1152 - Testing of Copper Links
 9. BICSI Telecommunications Distribution Methods Manual, 13th edition or most recent edition at the time of installation.
 10. TIA 758-A - Customer owned Outside Plant Telecommunications Infrastructure Standard (2004), including all applicable addenda and the most recent revision at the time of installation.
 11. BICSI Information Transport Systems Installation Manual - 5th edition or most recent edition at the time of installation.
 12. ANSI/NFPA-70 - 2017 National Electrical Code, revision, or most recent revision at the time of installation.
 13. ANSI/IEEE C-2 - 2017 National Electrical Safety Code or most recent revision at the time of installation.
 14. OSHA Standards and Regulations All applicable
 15. Local Codes and Standards All applicable
- C. Note: Anywhere cabling standards conflict with electrical or safety codes, Contractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either. Knowledge and execution of applicable codes is the sole responsibility of the Installer. Any code violations shall be remedied at the Contractor's expense.

1.7 ACCEPTABLE MANUFACTURERS:

A. General:

1. Unapproved product substitutions are not allowed. Contractor wishing to substitute any products for those expressly specified shall submit three samples of the alternate product to Engineer no less than two weeks prior to the last addendum accompanied by all engineering documents, drawings and third party test data proving mechanical and transmission equivalency. Acceptance of substitutions shall be received from Engineer in writing. All unapproved substitutions installed shall be removed by Contractor who shall assume all costs for removal and replacement with approved products. Such costs shall include, but not be limited to labor, materials, as well as any penalties or fees for late completion.

B. APPROVED MANUFACTURERS:

1. Contractor shall select only one line item in the each section of Parts 2, 3, and 4. Contractor shall NOT utilize multiple line items for the project within each Part. For example, if Panduit / General Cable is selected to be used for the project, all copper cabling and connectivity shall be by Panduit or General Cable. No other manufacturer or combination of manufacturers may be used for the copper cabling or connectivity equipment.
2. Copper Cabling / Connectivity Approved Manufacturers:
 - a. CommScope
 - b. Panduit/General Cable
 - c. Leviton / Berk-Tek
 - d. Siemon
 - e. Belden/ Mohawk
3. Fiber Cabling Approved Manufacturers
 - a. Same manufacturer from Part 2.
 - b. Corning
4. Non-Cabling / Connectivity Approved Manufacturers:
 - a. Same manufacturer from Part 2.
 - b. Chatsworth

1.8 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. All products shall be in new condition and UL listed.
- B. Provide complete raceway, outlet boxes and miscellaneous items. All conduit utilized shall be EMT grade.
- C. Provide 5" x 2.875" (or 4-11/16" x 3.25" square) deep square outlet box at each outlet location with single gang plaster or tile ring. Provide wall board adapters / accessories as necessary.
 1. Approved solutions:
 - a. RANDL 5 Square Telecommunications Outlet Box Model TX-550-YY where "X" could be a bracket box and "YY" could be knockout arrangements.

- b. Hubbell Large Capacity Wall Box Model HBL260. If a 2" knockout is required for installation purposes, provide this box.
- D. Communication grounding and bonding shall be constructed and installed to meet or exceed the requirements of the National Electrical Code (NEC), IEC 1000-5-2 and ANSI/J-STD--607-A throughout the entire grounding system.
- E. All termination hardware shall be rated to meet specified cabling specifications.

2.2 **ENTRANCE FACILITY (EF) / EQUIPMENT ROOM (ER) / TELECOMMUNICATIONS ROOM (TR)**

A. General:

- 1. Contractor shall be responsible for the adequate and appropriate design of all racking systems, paying particular attention to sizing of all cable management troughs and supports both horizontal and vertical installation of patch panels and wire management into rack.
- 2. Provide line surge suppressors at main telephone board in ER for all incoming phone lines if not provided by service provider. Provide ground connection to TMGB.

B. Provide the following, see specifications for each item in this document:

- 1. Wall Linings in each EF, ER, and TR:
 - a. In addition to the architectural walls, provide plywood wall lining that mounts at 8" A.F.F that shall:
 - i. Be fire-rated or treated on all sides with at least two coats of fire-resistant light-colored paint. Fire-retardant plywood is also acceptable. Leave fire rated stamp on plywood unpainted.
 - ii. Have walls lined with A/C grade or better, void-free plywood, 8 feet high with a minimum thickness of ¾". See plans for additional wall locations.
 - iii. Install the plywood with grade A surface exposed. Plywood shall be securely fastened to wall-framing members to ensure that it can support attached equipment.
 - iv. Use flush hardware and supports to mount plywood.
 - v. Plywood shall be void free and kiln-dried to a maximum moisture content of 15 percent to avoid warping.
- 2. Main Cross Connect (MC) / Horizontal Cross Connects (HC):
 - a. Floor Mounted Racks (See Plans for Locations):
 - 1. Refer to AV specs – 27 4100
 - b. Wall Mounted Cabinet (See Plans for Locations)
 - i. Provide black cabinet, with swing out cabinet body, perforated front door, and black color in the Coffee Shop Building. Door shall be lockable.
 - ii. Size cabinet to accommodate all passive equipment necessary. Plan for 12 RU minimum of active equipment.
 - iii. Provide horizontal slack manager and 3" cable bend radius posts.
 - iv. Provide cabinet fan kit.
 - v. Approved Equipment
 - 1. Chatsworth CUBE-iT Plus Cabinet System.
 - 2. Belden XHW-4830-GD with XHWFANKIT115V

c. Copper Patch Panels:

- i. Provide flush mount patch panels of required number and size to accommodate shown telecommunications outlets on plans. (No horizontal cable managers are required)
- ii. Size panels to provide minimum 25% spare capacity. Fill all available space in remaining patch panels so that panels are fully populated.
- iii. Support Category 6 or higher applications.
- iv. Shall accommodate 8-Pin 8-Contact (8P8C) ports.
- v. Mount to standard EIA 19" rack.
- vi. Each patch panel shall include mounted behind it one "towel rack" style cable support bar for each 24 connections that the Contractor shall dress cables using hook and loop type cable ties.
- vii. Approved Equipment

48-Port Patch Panel Cat 6		
<u>Manufacturer</u>	<u>Model Name</u>	<u>Flat Patch Panel</u>
CommScope	Uniprise	UNP-6-DM-2U-48
Panduit	NetKey	NK6PPG48Y
Leviton	Leviton	69586-U48
Siemon	HD	HD6-48
Belden	Rev	RV6PPF2U48BK

d. Fiber Shelves and Cassettes

- i. Provide fiber shelves and cassettes as required to complete project with a maximum of 36 strands in 1RU.
- ii. Provide rack mounted, sliding type fiber trays as required to complete project.
- iii. Provide OM3 fiber adapter patch panels that contain modular, dual LC adapter panels as required to complete project. Color for OM3 ports to be aqua.
- iv. Provide minimum 25% spare capacity of fiber adapter panels. Provide additional rack mounted fiber trays/fiber adapter patch panels if necessary to meet 25% spare capacity requirement.
- v. Approved Equipment

<u>Manufacturer</u>	<u>Model Name</u>	<u>Fiber Shelf</u>	<u>Cassette (OM3)</u>
CommScope	Systimax 360	SD-1U-FX	PNL-CS-12LCX-PT
Panduit	HD-FLEX	FLEX1U06	FHSXO-12-10P
Leviton	Opt-X	5R1UM-S03	SPLCS-12A

Corning	CCH	CCH-01U	CCH-CS12-E4-P00TE
Siemon	FCP3	FPC3-DWR	FSM2-12-LC5L-01
Belden		ECX-01U	FC3X06LDFS + FTL3LC900PR12

e. Vertical Cable Managers:

- i. Provide a vertical cable management panel on both sides of rack.
- ii. Manager shall consist of a metal backbone with cable management fingers that align with EIA rack spacing. Provide cover for all cable management.
- iii. Vertical panel shall be able to manage all the cable on the rack without the aid of horizontal cable managers.
- iv. Size all vertical cable managers according to factory recommendations for the cable being installed. In no case shall design require more than 35% fill ratio when rack is fully populated.
- v. Provide molded plastic slack spools in front to facilitate minimum bend radius compliance.
- vi. Minimum width to be 6".
- vii. Approved Equipment
 1. Chatsworth Velocity Double Sided 1391X-703
 2. CommScope VCM-DS-84-xB (6", 8", 10", 12").
 3. Panduit PatchRunner PRV6
 4. Leviton 8980L-VFR (8")
 5. BHVHH06 with BHSK020

f. Horizontal Cable Management

- i. Provide horizontal cable management capable of managing copper and fiber cables.
- ii. Manager shall consist of bend radius control throughout the fingers, pass through holes, and transitions between horizontal and vertical pathways.
- iii. Provide front hinged cover that shall open 180 degrees.
- iv. Manager should mount to standard EIA 19" rack.
- v. Size according to factory recommendations for the cable being installed. In no case shall design require more than 40% fill ratio when rack is fully populated.
- vi. Approved Equipment
 1. Panduit NMFEX, where X refers to the number of rack units
 2. CommScope HTK-19-SS-XU, where X refers to the size.
 3. Leviton 492RU-HFR (2RU) or 491UR-HFR (1RU)
 4. Chatsworth 13930-70X (X denotes 1-3 RU)
 5. BHH191UR / BHH192UR

g. Uninterruptible Power Supply (UPS)

- i. Provide 1500VA, 120V rack-mounted UPS for each rack/cabinet on project with capability of providing backup to the full connected

load for a minimum of 10 minutes, regardless of shown load on electrical panel schedules.

- ii. Provide a minimum of (2) output receptacles.
- iii. Provide submittal for each UPS showing run time graph that shows compliance with the specifications.
- iv. Approved Manufacturers
 - 1. APC
 - 2. Eaton

h. Cable Tray (only within the EF/ER/TR)

- i. This cable tray section is only applicable within the EF/ER/TR and does not apply outside of those spaces. See specification 26 0536 Raceway Systems for any cable tray requirements outside of the EF/ER/TR (if applicable to the project.)
- ii. Provide overhead ladder tray:
 - 1. Tray shall have minimum 6" rung spacing.
 - 2. Mount tray 18" above racks unless otherwise noted. Provide additional vertical tray as required to provide pathways between the tray above racks and the tray entering the communications room from outside.
 - 3. Size tray according to quantity of cables entering space. However, in no case shall the tray be smaller than 4" high by 6" wide. Do not exceed 50% cable fill of tray.
 - 4. For overhead installations, utilize profile supports to support tray every 5'-0".
 - 5. For wall mounted installations, utilize shelf brackets to support tray every 5'-0".
 - 6. Provide blind ends to provide closure for a dead-end tray.
 - 7. Provide cable rollers, two at each 90-degree bend. A radius shield or horizontal bend radius may also be used in lieu of cable rollers.
 - 8. Provide drop-out fittings, or waterfalls, over each cabinet of sufficient quantity to provide an acceptable path for cables to enter equipment. For single cables leaving the tray, utilize a cable drop-out in lieu of a waterfall.
 - 9. Cables must enter the racks from the top.
 - 10. Provide conduit to tray adapters for each conduit terminating to cable tray.
- iii. Acceptable Manufacturers
 - 1. Chatsworth Universal Cable Runway
 - 2. Cooper B-Line Redi Rail Runway
 - 3. Cablofil PW Ladder Tray
 - 4. CommScope Cable Runway
 - 5. Panduit WyrGrid Cable Tray
 - 6. MonoSystems Series MR-16T

2.3 CABLING DISTRIBUTION SYSTEMS AND MISCELLANEOUS EQUIPMENT

A. General:
MILLCREEK COMMONS
TELEPHONE DATA SYSTEMS

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27 1500-8

1. Provide plenum rated cable/connectors if required, cabling/connectors must be appropriate for the environment that it is installed in. Provide wet rated cable for all wet locations, including any conduit in or below slab on grade.
 2. Contractor shall be responsible for sizing all pathways such that newly installed cable represents not more than a 35% fill as per manufacturer's directions. Overfilled pathways are the sole responsibility of the Contractor who shall remove and reinstall at Contractors expense.
 3. Provide products rated for the environment that it is installed in (i.e. riser, plenum, outdoor). All cabling installed in wet locations (i.e. underground conduit, conduit in slab on grade) shall be listed for use in wet locations.
- B. Backbone Cabling Distribution System – Optical Fiber

1. General:

- a. Provide an optical fiber backbone cabling distribution system between telecommunication spaces. Provide OFNR or OFNP as required. Provide 900µm tight-buffered optical fiber cable for premise cable and loose tube for outside plant cable.
- b. Provide fiber jumpers of appropriate length and cable type for each terminated optical fiber port to be connected.

2. Multi-Mode Fiber Optic Cable (OM3)

- a. All multimode optical fiber cabling shall be 50µm/125µm micron laser-optimized cable, designation OM3.
- b. Provide two strands between each EF/ER, ER/TR, and TR/TE for each 48-port patch panel. Provide a minimum of 6-strands of fiber between telecom rooms unless otherwise noted on plans. Provide 25% extra fiber pair strands if more than 6-strands are required. See riser diagram for additional information.
- c. Approved Equipment

<u>Manufacturer</u>	<u>Model</u>	<u>Indoor/Outdoor</u>
General Cable	NEXTGEN	BE###4M1D-DT
CommScope	LazrSPEED 550	P-###-OD-5K
Berk-Tek	GIGALite	LTPxxx-EB3010
Corning	MIC Cable	COR-xxxT8P-31180-29
Siemon		9GD5(x)(xxx)(x)-T301A
Belden		FD3DxxxR9

3. Connectors:

- a. Provide LC-Duplex Connectors.
- b. Mechanical connectors are acceptable. Do not utilize polish type connectors. Clean all preterm connectors, no exceptions.
- c. **For all simplex connectors, provide duplex type clip.**
- d. Approved Manufacturers:

<u>Manufacturer</u>	<u>Multi-Mode (OM3/4)</u>
CommScope	<u>MDC-LCR-16-BG</u>
Panduit	<u>FLCDMx</u>
Leviton	<u>49990-LDL</u>
Corning	95-051-98-SP-X
Siemon	FC1-LB-SC5-9AQ
Belden	FT3LC900FS01

C. Backbone Cabling Distribution System – Copper

1. General:

- a. Provide copper backbone distribution system between telecommunication spaces as shown on drawings.
- b. Provide Hitachi cable (**Drybit Category 6 Indoor/Outdoor Cable**) for the location requiring plenum indoor/outdoor cable or the conduit shall be run all the way back to the data room with non-plenum indoor/outdoor cable. NO transition point is permitted from outdoor to indoor cabling.

2. Backbone Cabling Distribution System

- a. Provide multiple pair Cat 5e cable with wire count as shown on drawings.
- b. Provide copper patch cables of appropriate length and cable type for each terminated patch panel port with an additional 25% spare.
- c. Acceptable Manufacturers:
 - i. Copper backbone cabling shall be by same manufacturer as copper horizontal cabling.

3. Primary Protection (Surge Protection)

a. General

- i. Provide surge protection for each pair of copper cabling between buildings and any end point devices that are located outside. For example, if a camera is mounted or located on the exterior of the building—surge protection is required.
- ii. Surge suppressions shall be achieved through 5-pin, solid state, plug-in type modules for each conductor pair.
- iii. Provide necessary grounding of equipment to building electrical ground. Size all grounding conductor based on distance to electrical ground according to the requirements of this section.
- iv. Provide 25% spare modules.

v. Approved Equipment

1. For data outlets where POE is present
 - a. ITWLinx 1Gb CAT6-POE.
2. For outlets where no POE is present
 - a. ITWLinx 1Gb CAT6-LAN
3. For copper multi-pair backbones
 - a. ITWLinx ML25-CAT5-75
4. If power is required on all four pairs. (Note: If Cisco switches are connected via a copper backbone, this product is required.)

a. ITWLinx 1Gb CAT6-75

D. Horizontal Cabling Distribution System – Balanced Twisted Pair

1. General:

- a. Provide appropriate number of Category 6 horizontal cables, patch cables, work area cables, for all terminated data drops, between switches, etc. so that building-wide networking will be operational once all installation is complete.

2. Horizontal Cabling

- a. Provide Cat 6 UTP, min-compliant, 4-Pair 100Ω Balanced Twisted Pair Cable to all locations shown on plans.
- b. Provide cabling rated for the environment that it is installed in (i.e underground conduit, conduit in slab on grade). All cabling installed in wet locations shall be listed for use in wet locations.
- c. Provide a minimum of (2) cables, unless otherwise noted, to each location shown on plans.
- i. Provide (2) Category 6 cables to each wireless access point (WAP).
- d. Horizontal cable shall be blue.
- e. Approved Equipment

<u>Cat 6</u>		
<u>Manufacturer</u>	<u>Model</u>	<u>Plenum</u>
General Cable	GenSPEED 6	<u>7131800</u>
CommScope	Uniprise	<u>6504</u>
Berk-Tek	LANmark-6	<u>10136226</u> (Blue, CMP)
Siemon		9C6P4-E3-06-RXA
Belden		2413

f. Field Terminable Plug (FTP)

- i. Provide an FTP for each camera and WAP. Provide one FTP for each camera and two FTPs for each WAP. Confirm FTPs are compatible with WAPs and Cameras.

g. Approved Equipment

<u>WAP/Camera Field Terminable Plug</u>	
<u>Manufacturer</u>	<u>Model</u>
Panduit	FP6X88MTG
Leviton	6APLG-S6A
Siemon	ZP1—6AS-01S
Belden	RVAFPUBK-S1

3. Patch and Work Area Cables:

- a. Provide and install (1) 7-foot-long patch cable for each workstation and (1) 7-foot patch cable for each patch panel port in the TR/TC. Provide.
 - b. No patch or work area cords shall in any case exceed in total 10 meters as per TIA Standard unless design includes Standards compliant MUTOA (multi-user termination outlet) and work area cord adjustments are made according to recommendations for zone cabling contained within TIA 568-C or most recent revision at the time of installation. Coordinate with owner for preferred patch cord lengths at patch panel and work area.
 - c. Copper patch cord and work area outlet cabling must be provided by the same manufacturer and meet the same performance standards as the horizontal cabling.
 - d. Patch cord and work area cables shall be blue.
 - e. Provide (1) 5 foot, 2-strand optical fiber patch cable for each patch panel, utilizing same performance standards and connector types as specified for the backbone. The cable shall be provided by the same manufacturer and meets the same performance standards as the backbone optical fiber.
4. Telecommunications Outlets/Connectors (See Plans for Locations):
- a. Sloped Faceplates:
 - i. Provide modular type information outlets with sloped telephone jack or data outlet. Provide single gang faceplate kits to allow up to six data or voice jacks as shown on plans. Provide faceplate kits for wall outlets in colors and materials that match power wiring device plates. Provide faceplate kits that allow labeling schemes described herein. Faceplates shall accept STP, UTP, fiber optic or audio/video modules as an option.
 - ii. Blank off all unused ports.
 - iii. Color: Standard color as selected by owner/architect.
 - b. Connector:
 - i. Color: Standard color as selected by owner/architect.
 - c. Approved equipment

<u>Connector</u>		
<u>Manufacturer</u>	<u>Model</u>	<u>Connector Cat 6</u>
CommScope	GigaSPEED XL	MGS400-xxx
Panduit	NetKey	NK688Mxx
Leviton	QuickPort, eXtreme	61110-Rx6
Siemon		MX6-(xx)
Belden		RV6MJKUxx-S1

<u>Flat Plate</u>		
<u>Manufacturer</u>	<u>Model</u>	<u>Plastic Faceplates</u>
CommScope	GigaSPEED XL	M1XI-262

Panduit	Netkey	NK3FNE
Leviton	QuickPort, eXtreme	42080-xxL
Siemon		MX-FP-S-(xx)-(xx)
Beldon		AX102249

PART 3 – EXECUTION

3.1 GENERAL

- A. Prior to pathway rough-in, low voltage contractor shall meet with electrical contractor to review pathway installation requirements.
- B. Pathway Requirements:
 1. General:
 - a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.
 - b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any major obstructions not identified on plans need to be determined at that time with the Engineer.
 - c. Paint all electrical boxes and their covers for the telephone and data system green (Kwal Paint Java Green AC098N).
 2. Cable Tray Within EF/ER/TR:
 - a. Wrapped around room (wall support is acceptable)
 - b. Along equipment rows leading to cross-connects.
 - c. Ground tray to TGB or TMGB (whichever is closer) utilizing #6CU bare wire.
 - d. Coordinate tray locations with lighting, air-handling systems, and fire extinguishing systems so that fully loaded trays will not obstruct or impede their operation.
 - i. Install cable tray under mechanical components for access for future cabling needs; coordinate the mounting height of the cable tray with Owner IT Representative prior to installation. Do not install cable tray at the top of a ceiling which is inaccessible due to the excessive height.
 3. Racks / Cabinets:
 - a. Racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.
 - b. Racks shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.
 4. Conduits:
 - a. For any interior/exterior conduit 4" and larger, provide (3) 1.25" plenum-rated corrugated innerducts.

- b. Flexible conduit is not acceptable as cable tends to creep, shift, or have sheath damage.
 - c. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
 - d. Conduit runs shall not have continuous sections longer than 100 feet without a pull box and may only be filled to 35% capacity.
 - e. Ream all conduit ends and fit with an insulated throat nylon bushing with non-indenter type malleable steel fittings to eliminate sharp edges.
 - f. Telecommunications conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.
 - g. Conduits that enter an EF/ER/TR must terminate near the corners to allow for proper cable racking. Terminate these conduits as close as possible to the wall where the backboard is mounted to minimize the cable route.
 - h. Terminate conduits that protrude through the structural floor 1" to 3" above the surface within an EF/ER/TR.
 - i. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.
 - j. A 200lb pull cord (nylon, 1/8" minimum) shall be installed in any empty conduit.
 - k. When the number of conduits requires more than one row, restrict the number of rows to two wherever practicable.
5. Open Top Cable Support Requirements:
- a. Provide wide surface area open-top cable supports spaced 5 feet apart at the maximum to adequately support and distribute cable's weight. Follow manufacturer specifications for cable loading. Provide supports that have a galvanized finish with wide base specifically for telecommunications cabling.
 - b. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables
 - c. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 - d. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports.
 - e. Approved Equipment
 - i. Erico Caddy-Cat HP
6. Pull Box Requirements:
- a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.
 - b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90-degree bends, or contain a reverse bend.
 - c. Conduits that enter the pull box from opposite ends should be aligned.

- d. Pull boxes shall have a length 12 times the diameter of the largest conduit.
 - e. All pull boxes must be accessible.
- C. Cabling System:
 - 1. Follow T568B scheme for copper cabling terminations.
 - 2. Life Safety Related Cabling:
 - a. Provide the specified category cabling in 1" conduit from elevators and or lifts. Cabling shall terminate at telephone service demarcation point. .
 - b. Provide the specified category cabling in 1" conduit for two phone lines to the fire alarm control panel back to telephone service demarcation point.
 - c. Provide the specified category cabling in 1" conduit for the two-way communication system Main Control Panel back to telephone service demarcation point.
 - 3. Miscellaneous Related Cabling:
 - a. Provide the specified category cabling in 1" conduit for two data connections to Intrusion Detection System head-end back to EF or demarcation room. Refer plans for exact locations.
 - b. Provide the specified category cabling in 1" conduit for two data connections to Access Controls System head-end back to closest data rack. Refer to plans for exact locations.
 - c. Provide the specified category cabling in 1" conduit for one data connection to Intercom head-end back to closest data rack. Refer to plans for exact locations. Provide specified category cabling and conduit between intercom head-end and access control panel.
 - d. Provide the specified category cabling in 1" conduit for Main Building Management System (ATC Panels, etc) back to nearest ER/TR room. Refer to Mechanical plans for exact location.
 - e. Provide the specified category cabling in 1" conduit for Advanced Energy & Power Metering System back to Main Building Management System Panel. Refer to plans for main switchboard location.
 - 4. Backbone cables shall be installed separately from horizontal distribution cables. Provide plenum rated innerduct if required, innerduct must be appropriate for the environment that it is installed in.
 - 5. It is acceptable to install innerduct within cable tray as long as the fill ratio is not exceeded.
 - 6. Fiber slack shall be neatly coiled within the fiber enclosure or cable tray. No slack loops shall be allowed external to the fiber panel. Each cable shall be individually attached to the respective fiber enclosure by mechanical means.
 - 7. Provide a minimum of one balanced twisted pair cable to each voice outlet and one balanced twisted pair cable to each data outlet shown on the drawings unless noted otherwise on the drawings.
 - 8. Service Loop Requirements
 - a. Provide a minimum 6" service loop in each communications system junction box for balanced twisted pair. Cables shall be coiled in the in-wall boxes if adequate space is present to house the cable coil without exceeding manufacturers bend radius.
 - b. Provide a minimum 10' service loop in each EF/ER/TR/TE.

- c. Provide a minimum 2' service loop at each stub-up or at each transition from conduit to cable tray.
 - d. Provide a 5' service loop in the ceiling before the conduit travels down the wall and terminates into the communications junction box.
 - e. Provide a 25' loop at all wireless access point (WAP) locations above the ceiling.
- 9. Provide modular jacks for each installed cable at outlets shown on drawings. Blank off all unused ports on faceplate.
- 10. Provide Velcro type ties for all cables and install in a neat and workmanlike manner. Where applicable, use plenum rated Velcro. Where cable is installed in cable tray, bundle a maximum of 25 cables in each Velcro tie. No zip ties are permitted whatsoever, even for temporarily hanging cables during the installation process
- 11. The bending radius and pulling strength requirements of all backbone and horizontal cables shall be observed during handling and after installation. Use pulling compound as recommended by manufacturer.
- 12. All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.
- 13. The combined length of all patch cords in the EF/ER/TR and the work area shall not exceed 10m (33 ft)
- 14. No splices are allowed.
- 15. In a false ceiling environment, a minimum of 3 inches shall be observed between cable supports and false ceiling. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- 16. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- 17. Cables shall not be attached to ceiling grid seismic support wires or lighting fixture seismic support wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- 18. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- 19. Pulling tension for balanced twisted pair shall not exceed 25lbf and for optical fiber shall not exceed 50lbf.
- 20. Pair untwist at the termination shall not exceed 0.125". The cable jacket shall be maintained as close as possible to the termination point.
- 21. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- 22. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.
- 23. Copper Backbone Terminations:
 - a. Terminate one single pair on pins 4, 5 at each patch panel port. Terminate all pairs on patch panel located on rack.

D. Grounding System:

1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.
2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
3. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.
4. All active equipment from owner shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.
5. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially – daisy-chained rack grounds will not be accepted.
6. Patch panels shall be bonded to racks using the appropriate bonding screws. Mounting rails may utilize cage nuts, threaded holes or thru hole mounting fasteners to secure patch panels to the rails.
7. Bond cable tray, raceway system, structural steel and all other metal equipment located within EF/ER/TR to the grounding bus bar utilizing copper conductors per the following schedule:
 - a. $\leq 25'$ - #34
 - b. $\leq 50'$ - #2
 - c. $\leq 66'$ - #2/0
 - d. $\geq 67'$ - #3/0
8. Provide 4" X 12" X 1/4" CU Telecommunication Main Grounding Bus Bar (TMGB) with bonding conductor per schedule above to Intersystem Bonding Terminal (IBT) in each telecommunication room (EF/ER/TR) with a main cross-connect (MC). Provide 20% spare termination spaces on bus bar, provide additional bus bars as necessary to accommodate spare.
9. Provide 2" X 12" X 1/4" CU Telecommunication Grounding Bus Bar (TGB) with bonding conductor per schedule above to TMGB in each room with a horizontal cross-connect (HC).
10. Refer to electrical diagrams for additional ground connection requirements.

E. Electromagnetic Compatibility:

1. General:
 - a. Do not install power feeders above or within the telecommunications room. Do not install telecommunications conduits above electrical panelboards, switchboards, transformers, motor control centers, etc.
 - b. Where telecommunication cable is installed in grounded, metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables:
 - i. Circuits Under 5kVA: 2" minimum separation.
 - ii. Circuits Over 5kVA: 6" minimum separation.
 - iii. Electrical motors/transformers: 48" minimum separation.

- iv. Lighting ballasts: 6" minimum separation.
 - c. Where telecommunication cable is installed in cable tray or underground in non-metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables by a minimum of 12"
- F. EF/ER/TR Power Requirements:
 - 1. General: Regardless of what is shown on drawings, the minimum requirements for providing power in the EF/ER/TR are as follows and shall be included in bid:
 - a. Two dedicated, nonswitched 120V/20A duplex receptacles, each on individual branch circuits.
 - b. 120V/20A Duplex receptacles located +6" A.F.F. placed at 6 foot intervals around perimeter walls. Up to 10 receptacles may be placed on a single circuit.
- G. Firestopping and Smoke/Acoustical Pathways(See Also Division 7):
 - 1. Provide firestop/smoke barrier solution equivalent to the wall/ceiling/floor rating.
 - 2. Provide firestop labels next to each penetration with written date. Label both sides of the penetration.
 - 3. Firestop systems shall be UL Classified to ASTM E814 (UL 1479). A drawing showing the proposed firestop system shall be provided to the Engineer prior to installing the Firestop system(s).
 - 4. Utilize firestop pass-through type devices for medium to large penetrations into fire walls/floors.
 - 5. Provide a minimum of (4) 4" trade size Hilti Speedsleeves (or STI EZPath) with at least one spare for each and every firewall penetration where cable tray meets the wall.
 - 6. Provide the following products:
 - a. Fire Rated; STI EZ-Path Fire-Rated Pathways Series (or Hilti Speed Sleeve CP 653 BA)
 - b. Smoke/Acoustical Rated; STI EZ-Path Smoke & Acoustical Pathway Series (or Hilti Smoke and Acoustic Sleeve CS-SL SA)
- H. Miscellaneous Equipment:
 - 1. Arrange all terminal blocks in a manner that allows natural wiring progression and minimizes crossing of wires.
 - 2. Provide patch cords and cross connect cables as necessary for a complete operational telephone and data network system. Consult with owner to determine any special needs such as dedicated phone lines.

PART 4 – LABELING

4.1 GENERAL

- A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

- B. All telecommunications spaces, pathways, cables, connecting hardware, equipment, racks, patch panels, outlet/connectors, and grounding system shall be labeled in accordance with TIA/EIA 606-A.
- C. All outdoor data outlets shall be weatherproof. Outlets must be hidden behind the mounted devices.
- D. All labels shall meet UL 969 requirements for legibility, defacement and adhesion requirements. Handwritten, Ink, or Laser Printing labels are not allowed. Provide labels using thermal transfer print. Heat shrinking or wraparound labels are required, flag style labels are not allowed.

4.2 TELECOMMUNICATION PATHWAYS

- A. Identify each dedicated pathway (including inner ducts) for the voice and data system.
- B. Label pathways at regular intervals and wherever they are accessible.

4.3 TELECOMMUNICATION CABLES

- A. Identify cables at each end with a permanent label or physical/electronic tag.
 - 1. The same alphanumeric identifiers should be used at both ends of the cable.
 - 2. Identify cables at regular intervals throughout and wherever they are accessible.
 - 3. Cables shall be identified in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate that can be accessed by removing the cover plate and to the cable behind the patch panel on a section of cable that can be viewed without removing the bundle support ties. Cables labeled within the bundle where the label is obscured from view shall not be acceptable.

4.4 CONNECTING HARDWARE

- A. Identify connecting hardware items (termination blocks, cross-connects, racks, cabinets, patch panels, telecommunications outlet/connectors, ports) using alphanumeric identification such as the following three-level scheme:
 - 1. First level—Termination field or patch panel. Color-coding or other labeling should be used to uniquely identify each termination field (e.g., voice and data) on a common mechanical assembly.
 - 2. Second level—Terminal block within a given field or patch panel that could be a row of insulation displacement connectors (IDCs), optical fiber connectors, or modular jacks.
 - 3. Third level—Defines the individual position within a given terminal block or patch panel.

4.5 TELECOMMUNICATIONS GROUNDING SYSTEM

- A. Identify each telecommunications grounding bus bar (TGB) and telecommunications main grounding bus bar (TMGB).
- B. Identify each grounding conductor relating to the telecommunications system, including those connecting building steel, grounding electrodes, water pipes, and telecommunications structural components.

PART 5 - MISCELLANEOUS

5.1 TESTING:

- A. General

1. Provide testing within 10 days of completion for all copper and fiber optic cable according to TIA/EIA standards and any other requirements of the manufacturer who will provide warranty.
2. Submit copy of current calibration of all testing equipment. Submit all test reports electronically to architect/engineer and include in O&M manuals to include test reports. Meter shall have been calibrated within the past 12 months.
3. Correct any malfunctions. Contractor shall re-terminate/replace any cable, connection, or equipment found to be defective or non-compliant with these specifications and referenced standards.
4. Invite Owner IT representative and Engineer to witness and/or review field testing. Notify five business days prior to commencing testing.

B. Copper Cable

1. Utilize Level IIIe, IV, V Tester to test all equipment and each outlet, horizontal cable, termination block, patch cords, etc. to verify compliance with requirements. Testing shall consist of industry accepted verification tests for the Category of cable installed and shall meet latest requirements of EIA/TIA cabling Standards.
2. UTP Cable and Links: All UTP cabling channel must be tested at swept frequencies up to 250MHz for internal channel performance parameters as defined in IEEE 802.3an and ANSI/TIA/EIA-568C. Certifications shall include the following parameters for each pair of each cable installed:
 - a. Wire map (pin to pin connectivity)
 - b. Length
 - c. Insertion Loss
 - d. Near End Crosstalk (NEXT)
 - e. Attenuation to Crosstalk Ratio Far End (ACRF)
 - f. Return Loss
 - g. Propagation Delay
 - h. Delay Skew
 - i. DC Loop Resistance
 - j. DC Resistance Unbalance
 - k. Power Sum Near-End Crosstalk (PS-NEXT)
 - l. Attenuation to Crosstalk Ratio Near-End (ACR-N)
 - m. Power Sum Attenuation to Crosstalk Ratio Near-End (PS-ACR-N)
 - n. Attenuation to Crosstalk Ratio Far-End (ACR-F)
 - o. Power Sum Attenuation to Crosstalk Ratio Far-End (PS-ACR-F)
 - p. Transverse Conversion Loss (TCL)
 - q. Equal Level Transverse Conversion Transfer Loss (ELTCTL)
3. All channels that fail testing parameters will be replaced at the Contractor's expense until all channels pass the performance parameters.
4. Provide Modular Plug Terminated Link (MPTL) test for all field terminated plugs (standard for cameras and WAPs).
 - a. All installed cabling modular plug terminated links (MPTL) shall comply with the permanent link transmission requirements of the ANSI/TIA-568-2.D standard.

- b. The MPTL shall be tested with a Permanent Link Adapter on the Main Unit and a Patch Cord Adapter Suitable for Category 6A testing on the Far End or Remote Test Equipment.
 - c. Modular plug terminated link test results, including the individual frequency measurements from the tester, shall be recorded in the test instrument upon completion of each test for subsequent uploading for reports to be generated.
 - 5. Sampling is not acceptable. MPTL testing shall be performed on each cabling segment (connector to connector).
- C. Fiber Optic Cable
 - 1. Provide test results using an OTDR of all installed fiber optic links to demonstrate compliance with requirements. Testing shall consist of industry accepted verification tests for the type of cable installed and shall meet the latest requirements of EIA/TIA 455-53A standards. Test setup and performance shall be conducted in accordance with ANSI/TIA/EIA 526-14 Standard Method B.
 - 2. Provide inspection of fiber end faces by using scope and test according to IEC 61300-3-35 standards. Correct scratched, pitted, or dirty connectors.
 - 3. Provide bi-directional testing of cable for both cable rated wavelengths. Results shall show compliance of cable and shall include the following parameters:
 - a. Attenuation
 - b. Length
 - c. Verification of Polarity
- D. Owner reserves the right to hire an independent testing company to spot check the test results. If the results vary more than 10% from the results provided by the Contractor, the Contractor will be required to prove his results are correct or retest the entire system.

5.2 WARRANTY:

- A. Register installation with cable/connectivity manufacturer.
- B. Provide and submit all test results to owner, engineer, and manufacturer and meet all other manufacturer requirements in order to provide minimum 20-year extended product link warranty for complete cabling/connectivity installation, including all copper and optical fiber utilized on the entire channel. The channel warranty shall be provided by the connectivity manufacturer. Include replacement material and installation for any defective product.

5.3 OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.

5.4 TRAINING:

- A. Provide four hours training on the operation and installation of the structured cabling system at job site, at no cost to owner.

5.5 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

END OF SECTION 27 1500

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SECTION 27 4100

AUDIOVISUAL SYSTEM

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 work of this section.
- B. Division-26, 27 & 28 basic materials and methods sections apply to work specified in this section.
- C. Refer to specification 26 0553 for cabling, conduit and junction box color requirements.
- D. Refer to specification 27 1500 for category and/or optical fiber cable and connectivity specifications.
 - 1. Category cables used for transporting video, audio and controls simultaneously from transmitters to receivers and/or switchers shall follow the Manufacturer's recommend cabling specifications.

1.2 ADMINISTRATIVE REQUIREMENTS:

- A. BNA Project Contact:
 - 1. Joey Rooker, CTS-D
 - a. Phone: 801-532-2196
 - b. Email: jrooker@bnaconsulting.com
- B. Bid Submittal:
 - 1. Equipment Costs: Breakout cost of material and labor as different line items. Refer to bid form for breakout cost requirements.
- C. Coordination:
 - 1. Coordinate final inspection of the systems installed, with Audiovisual (AV) Consultant, three (3) weeks in advance.
 - 2. Obtain GANTT chart for construction time frame from the General Contractor.
 - 3. Coordinate with Electrical contractor to meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate the mounting condition of all ceiling-mounted AV equipment with ceiling type. During second meeting, coordinate the location of all ceiling-mounted AV equipment in each area.
 - 4. Meet with Electrical contractor prior to pathway rough-in to coordinate AV system requirements in each area.
 - 5. Meet at least once, prior to rough-in, with horizontal cabling installer to verify all AV network requirements. Coordinate cable color according to specification 26 0553.
 - 6. Meet at least twice with owner to coordinate AV network requirements. Hold the first meeting before submittal of shop drawings to coordinate network protocols, including but not limited to: IP address schedules, MAC address schedules, patchbay schedules, security requirements, and VLANs. Hold the second meeting prior to AV system deployment.
 - 7. Coordinate color and finish of all AV system components with Architect or Electrical contractor as appropriate.

- 8. Coordinate color (including custom color) and finish of all AV system components with Architect prior to ordering. Architect may require custom color of grills, face plates, etc. AV contractor shall paint or have devices painted by others. The cost for custom colors shall be within the AV Contractors Bid.
- 9. Notify AV Consultant when rough-in is complete and ready to inspect. AV Consultant and Electrical Engineer to sign off on rough-in prior to rough-in resuming rough-in for typical rooms.
- D. Contractor is responsible for coordinating with all other trades for equipment locations, mounting requirements, supports and plenum space requirements.
- E. AV contractor shall participate in a mandatory pre-construction meeting no more than sixty (60) days prior to ordering equipment, and before work can begin. Contractor is responsible for coordinating the meeting. The meeting will be held at the AV Consultant's office. All submittals, shop drawings and bills of materials shall be completed and submitted to AV Consultant for review eight (8) working days prior to this meeting.
- F. AV contractor shall attend the electrical pre-construction meeting per specification 26 0500.

1.3 DESCRIPTION OF WORK:

- A. Provide the specified systems in a complete and operating condition with all necessary materials and labor to fulfill the requirements and the intent of the drawings and specifications. Except as otherwise indicated, provide manufacturer's standard system components. Contractor shall furnish all cables, materials and equipment, whether specifically mentioned herein or not, to ensure a complete and functional system.
- B. Master quotes do not relieve contractor from performing due diligence for equipment type, equipment quantity, and quantity of room types. Any errors, conflicts, or omissions between the drawings and/or specifications and master quotes shall be the responsibility of the contractor to resolve.
- C. Bidders wishing to provide equipment other than the equipment specified shall submit proposed substitute equipment to AV Consultant eight (8) working days prior to bidding. Submittals for prior approval shall include description of equipment, design intent, complete riser diagrams for proposed equipment, equipment specifications, cut sheets of proposed equipment, reason for alternate equipment. AV Consultant may request physical equipment to test and demo. Acceptance of proposed equipment by AV Consultant shall not relieve AV contractor from responsibility to provide audio-visual systems equal to those specified in this Section. Contractor shall be ultimately responsible for providing complete and working audio-visual systems that function, control and operate in the same manner as the specified equipment. AV Consultant has final say if proposed equipment is equal to the specified equipment. Equipment that AV Consultant is not familiar with will require the contractor to provide manufacturer training at manufacturer's facility and have a manufacturer representative present at time of commissioning.
- D. Equipment submitted in the bid proposal that has not been approved by AV Consultant in writing will not be accepted and shall be replaced by approved equipment at contractor's expense. Equipment not listed within this specification, or contract documents, that is required for a complete and working system, shall be of professional grade and used in the same manner as needed for a complete and working system.
- E. Input plates shall match the color and style being used throughout the project.
- F. All control processors and controllers are to be on an unswitched power connection.

1.4 QUALITY ASSURANCE:

- A. Installer:

1. Integrating firm shall have worked satisfactorily for a minimum of five (5) years of completing systems equal to this scope, quality, type and complexity.
 2. Key personnel assigned to the project shall each have minimum of ten (10) years of experience in completing systems equal to this scope, quality, type and complexity.
 3. Contractor shall be a factory authorized distributor of all equipment specified for the geographical area of the project.
 4. Contractor shall maintain complete installation and service facilities for the duration of the project contract.
 5. Contractor shall have current manufacturer certificates for all AV systems and equipment listed within this specification.
 6. Contractor shall be in good standing with the owner.
 7. Contractors that do not meet the above requirements cannot bid on this project.
- B. Contractor must follow the standards described within:
1. BICSI/AVIXA AV Design Reference manual.
 2. ANSI/AVIXA 2M-2010 Standard guide for Audiovisual Systems Design and Coordination Processes.
 3. ANSI/AVIXA 10:2013 Audiovisual Systems Performance Verification Guide.
- C. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry best practices concerning grounding, shielding, cable dressing, cable termination and equipment mounting.
- D. PRE-APPROVED INSTALLERS:
1. Cache Valley Electric
 2. Digital Video Networks
 3. GenComm
 4. Hunt Electric
 5. Marshall Industries
 6. Performance Audio
 7. Poll Sound
 8. PST
 9. TPI
 10. WEBB AV
 11. Bids submitted by non-approved installers will not be accepted.
 12. Bidders not pre-approved shall submit in writing the following for review at least eight (8) working days prior to bid:
 - a. List of qualifications including:
 - i. Industries certifications including manufacturers.
 - ii. Approved resale manufacturers.
 - b. Past and current projects within the last five (5) years similar in scope and size.
 - c. Three (3) Different referrals from the owners of three (3) different projects within the last five (5) years.

1.5 SUBMITTALS: Refer to specification 26 0502 for shop drawing submittal requirements.

A.

- B. List of color options sent to the architect
- C. list of loudspeaker types and ceiling coordination, this needs a little bit more work on the noting.
- D. Provide shop drawings for 27 4100 at the time of original shop drawing submission. Do not order AV equipment from the first submission. One hundred and twenty (120) days prior to the time of AV equipment installation, provide a second submission of AV equipment only. Provide current equivalent if specified model has been discontinued.

1.6 WARRANTY:

- A. Systems shall be guaranteed for a period of one (1) year from the date of substantial completion against defective materials, inferior workmanship or improper installation adjustment. Guarantee shall cover all parts and labor.
- B. If system failure causes audiovisual system to be inoperative or unusable for its intended purpose, contractor, when notified of the problem, shall repair system so it will be operational and usable within three (3) business days. If defective components cannot be repaired in time, provide temporary equipment as required.
- C. Systems designed for twenty-four/seven (24/7) operation shall be repaired and/or replaced within twenty-four (24) hours of time of notification. If defective components cannot be repaired in time, provide temporary equipment as required.
- D. Contractor shall supply one (1) year warranty on all system programming from the date of substantial completion. During this time period, upon owner request, the contractor shall provide up to four (4) major programming changes free of charge. During this time the programs shall be password protected. At any time during the one (1) year, the owner can terminate the warranty and request the programming of each system. At this time the programs are to be turned over to the owner and all passwords are to be removed. The owner shall own all rights to the programming after this time, to be used in this facility. Provide the Owner written proof that all ownership has been relinquished.
- E. Contractor shall honor equipment warranties for term established by manufacturer if greater than warranty time frame mentioned above.

PART 2 – PRODUCTS

2.1 GENERAL:

- A. All equipment shall be installed as shown on the drawings and in strict accordance with the specifications. Any errors, conflicts, or omissions discovered in the specifications or the drawings shall be submitted in writing to the AV Consultant for clarification.
- B. Equipment lists are provided to identify quality and functional expectations. They may not be complete. Coordinate with devices shown on drawings, system risers and equipment lists for system intent. Provide a complete and functional system as described within the construction documents.

2.2 MANUFACTURER APPROVED EQUALS:

- A. The Manufacturers listed below have the potential to be considered equals, as it relates to the system design intent and the equipment specified herein. Any equipment chosen as equal to what has been specified in section 2.4 will be the responsibilities of the AV Integrator to coordinate all resulting changes and guarantee a complete and functional system e.g. rough-in requirements, programming, etc. Please note that some components have been chosen over others for features and/or size limitations. Equipment listed below with an asterisk have feature and/or size limitations and may not be substituted.
 - 1. Amplifiers – Ashly, Crestron, Crown, Extron, Lab Gruppen, Powersoft, QSC and StewartAudio

- a. Due to manufacturer shortages amplifiers will need to be ordered as quickly as possible. Please notify AV Consultant with lead times, changes in shipping and product availability.
- 2. Cables – Belden, Crestron, Extron, Gepco/General, Ice, Kramer, Liberty and Westpenn cables
- 3. Controls – AMX, Crestron and Extron
- 4. Displays – LG, NEC, Planar, Panasonic, Samsung, Sharp and Sony
- 5. DSPs – Biamp, BSS, Extron, QSC and Symetrix
- 6. Equipment racks – AtlasIED, Chief, Lowell and Middle Atlantic
- 7. Loudspeakers – AtlasIED, Bose, Community, JBL and SoundTube
- 8. Microphones – AKG, Audio Technica, Audix, Lectrosonics, Sennheiser and Shure
 - a. Auditorium wireless microphones alternates are not acceptable.
- 9. Mounts – Chief and Premier mounts
- 10. Networked Audio – Attero tech, Extron, RDL
- 11. Projection Screens – Da-Lite, Draper and Stewart Filmscreen
- 12. Video Equipment – AMX, Crestron, Extron
- 13. Wall plates – Attero tech, Crestron, Extron, RCI Custom, Liberty Panelcrafters and RDL

2.3 GENERAL EQUIPMENT REQUIREMENTS:

A. Loudspeakers:

- 1. Provide applicable mounting equipment as needed, including but not limited to; back boxes, mounting hardware, safety equipment, and seismic restraints.

B. Video Signal:

- 1. The equipment listed below is considered to be equal replacement parts for a point to point video solution as it relates to the system design intent. Equipment listed in section 2.4 override the equipment listed below.
 - a. Cable Equalizer for cable lengths exceeding 30' but no more than 75'
 - i. Extron – 'HD 4K 101 PLUS'.
 - b. Point to point HDBaseT extension, 18 Gbps, 4k60 4:4:4 at 70 Meters:
 - i. Crestron – 'DM-TX-4KZ-100-C-1G with DM-RMC-4KZ-100-C'.
 - ii. Extron – 'DTP2 T 211' with 'DTP2 R 211'.
 - c. HDMI cable lengths exceeding 30' without a cable equalizer, 18 Gbps, 4k60 4:4:4:
 - i. Extron – 'HD PRO P/##'.
 - a. '#' refers to the length of the cable.
 - d. Equipment that is not preapproved by the AV Consultant will not be accepted and will be replaced with the approved equipment at no cost to the Owner.

C. Audio Signal:

- 1. The equipment listed below is considered to be equal replacement parts for a point to point video solution as it relates to the system design intent. Equipment listed in section 2.4 override the equipment listed below.

- a. Passive or Active audio summing adapter:
 - i. Extron – ASA 131
 - ii. RDL – STA-1
 - b. Isolation transformer: RDL – EZ-HK1
- D. Equipment Racks:
 - 1. All AV equipment racks within this specification shall have the following accessories and/or features, either rack mountable or built into the rack, depending on the model of the rack. Refer to bid documents for all rack mounted equipment. Provide the following accessories as referred to in elevations. RUs are indicated in the elevations and noted with a # symbol in the part number.
 - 2. General Equipment
 - a. Shelving: Middle Atlantic – ‘SS’; 1RU shelf.
 - b. Drawers:
 - i. Nonlocking: Middle Atlantic – ‘D#’; #RU
 - ii. Locking: Middle Atlantic – ‘D#LK’; #RU
 - c. Header panel, located at the top of the rack:
 - i. RCI Custom – ‘BNA001-200120MM-01’
 - d. Blank plates: Middle Atlantic – ‘EB#’; #RU
 - e. Surge protection for all devices located within the rack. Surge protector shall be: 20 AMPs, rack mountable or mount to a side rail and at least 1,000 joules of protection.
 - i. Recommended Surge protector is Middle Atlantic – ‘PD-920R-SP’. Additional acceptable manufacturers are: Furman, Juice Goose, Tripplite and SurgeX.
 - f. Horizontal, vertical, and entry cable management.
 - i. All cabling shall be straight off of the back of equipment to horizontal supports connected to equipment rack. Cabling shall follow support to vertical supports when going into other components and/or out of the equipment rack.
 - ii. Cabling secured to other cabling and supported from the connector is not acceptable.
 - iii. Separate AC power and other signal types from each other.
 - g. 20 Amp rated power strips as necessary.
 - h. Sequencers
 - i. Provide a Middle Atlantic – ‘PDS-620R’ or Furman – ‘CN-2400S’ Sequencer.
 - ii. All equipment racks with the following equipment shall have a sequencer within the equipment rack. AV integrator to follow industry standards when using sequencers.
 - 1. Amplifiers
 - 2. Video processors without control processors
 - i. Active Thermal Management
 - i. Solid rear door.
 - ii. Fan kit totaling 190 CFM mounted on the top face of the equipment rack.

1. Thermostatic fan controller (set temperature range between 80 degrees and 90 degrees Fahrenheit.
 2. Fan guards
 3. Recommend equipment are Middle Atlantic – 'QBP-2' Blower panel or Middle Atlantic 'CAB-COOL50' Cabinet Cooler.
- iii. Blank panels on the front of the equipment rack in all unused rack spaces.
 - iv. Solid blank panels in unused rack spaces in top six (6) racks spaces.
 - v. Stack power amplifiers with 1 open rack space between.

2.4 EQUIPMENT REQUIRED PER ROOM TYPE

BUILDING SYSTEM EQUIPMENT SCHEDULE			
TYPE	DESCRIPTION	MANFR.	MODEL NO.
R1	EQUIPMENT RACK, STAND ALONE 77" TALL, 25" DEEP, 44 RU WITH VENTED FRONT DOOR	MIDDLE ATLANTIC	ERK-4425 WITH LVFD-44
M2	DUAL MICROPHONE INPUT, WALL PLATE WITH SOLDER CONNECTIONS	RDL	D-XLR2F
AX	AUXILIARY INPUT, WALL PLATE 3.5 MM & DUAL RCA STEREO	RDL	D-CIJ3D
T	DUAL MICROPHONE OUTPUT, WALL PLATE WITH SOLDER CONNECTIONS	RDL	D-XLR2M
	CD PLAYER WITH BLUETOOTH AND AUX INPUT	DENON	DN-300Z
KP1	SINGLE-GANG NETWORKED CONTROLLER	QSC	AXON C1
	DIGITAL SIGNAL PROCESSOR 8 IN, 8 FLEX, 8 OUT, AEC, VOIP, USB, AES67	QSC	CORE 110F
	POWER AMPLIFIER 4 CHANNELS X 600 WATTS	CROWN	DCi 4 600
W2	LOUDSPEAKER, COLUMN ARRAY, 87dB 1W/1M, 112dB MAX, 20° V x 160° H, 8Ω	BOSE	MA12EX W/CVT-MA12EX TRANSFORMER
W1	LOUDSPEAKER, IN-GROUND, 87dB 1W/1M, 100dB MAX, 50° V x 360° H, 4Ω	BOSE	FREESPACE 360P SERIES II
END OF SCHEDULE			

PART 3 – EXECUTION

3.1 INSTALLATION OF AV SYSTEMS:

- A. All cabling shall be installed in a minimum of 1" conduit to accessible ceiling space unless otherwise noted. Provide conduit to accessible ceiling space and then utilize non-continuous open top cable supports every 5'.
- B. Provide AV systems and ancillary equipment as indicated on drawings and in accordance with equipment manufacturer's written instructions, the NEC, and with industry best practices.
- C. Coordinate all work performed by other contractors pertaining to the AV system, including raceways, electrical boxes and fittings.

D. Video systems.

1. HDCP:

- a. All equipment within the signal path must be capable of processing HDCP-compliant material.
- b. All switcher, scalers, transmitters, and receivers shall reflect the HDCP compliance of the endpoint/display(s).
- c. HDCP shall be disabled in the switcher/scaler when a non-HDCP-compliant endpoint/display is used.

2. EDID Strategy:

- a. Permanent video sources shall be set manually within the equipment to output their native resolution. Video properties shall not rely on EDID.
- b. Portable video sources and wall plates shall use EDID tables within the switcher/scaler for preferred video properties. The EDID table shall be set with the following settings:
 - i. Most common resolutions within the display's aspect ratio.
 - 1. 3840 x 2160 (UHD) 60Hz, 4:4:4 Chroma sample
 - 2. 3840 x 2160 (UHD) 60Hz, 4:2:0 Chroma sample
 - 3. 3840 x 2160 (UHD) 30Hz, 4:4:4 Chroma sample
 - 4. 1920 x 1200 (WUXGA) 60Hz
 - 5. 1920 x 1080 (HDTV), 120Hz
 - ii. 1280 x 800 (WXGA), 60Hz, and RGB Color Space/RGB color space
 - iii. Stereo audio, 44,100 Hz, 16 bit

E. Pathway Requirements:

1. General:

- a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.
- b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any major obstructions not identified on plans need to be determined at that time with the Engineer.

2. Conduits:

- a. All cabling shall be installed in a minimum of 1" conduit to accessible ceiling space unless otherwise noted. Refer to AV symbol schedule for specific conduit requirements.
- b. Provide conduit to accessible ceiling space and then utilize non-continuous open top cable supports every 5' above accessible ceiling.
- c. Provide conduit from device to device in open and/or exposed ceilings. Ceilings with clouds are considered open/exposed ceiling.
- d. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
- e. Provide large radius elbows on all bends.

- f. Conduit runs shall not have continuous sections longer than 100 feet without a pull box. Refer to rough-in schedule for conduit fill capacity.
 - g. AV conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.
 - h. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.
 - i. A 200lb pull cord (nylon, 1/8" minimum) shall be installed in any empty conduit.
- 3. Open Top Cable Support Requirements:
 - a. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables
 - b. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
- 4. Pull Box Requirements:
 - a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.
 - b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90 degree bends, or contain a reverse bend.
 - c. Conduits that enter a pull box from opposite ends should be aligned.
 - d. Pull boxes shall have a length 12 times the diameter of the largest conduit.
 - e. All pull boxes must be accessible.
- F. Cabling System:
 - 1. Follow T568B scheme for copper category cabling terminations.
 - 2. Follow TIA/EIA-568A for commercial buildings cabling.
 - 3. Provide a minimum 6" service loop in each AV system junction box. Cables shall be coiled in the in-wall boxes if adequate space is present to house the cable coil without exceeding manufacturers bend radius.
 - 4. In a false ceiling environment, a minimum of 3 inches shall be maintained between cable supports and false ceiling. At no point shall cable(s) rest on lay-in ceiling grids or panels.
 - 5. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
 - 6. Cables shall not be attached to ceiling grid seismic support wires or lighting fixture seismic support wires. Where support for AV cable is required, the contractor shall install appropriate carriers to support the cabling.
 - 7. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
 - 8. Pulling tension for balanced twisted pair shall not exceed 25lbf and for optical fiber shall not exceed 50lbf.
 - 9. Pair untwist at the termination shall not exceed 0.125". The cable jacket shall be maintained as close as possible to the termination point.

10. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.
 11. Group multiple cabling together with expandable nylon loom, similar to Techflex - Flexo, when cabling exists a cavity and connects to a device. Cabling within a lectern, podium or millwork shall have expandable nylon loom sleeve as well.
- G. Grounding System:
1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.
 2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
 3. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.
 4. All active equipment shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.
 5. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially – daisy-chained rack grounds will not be accepted.
 6. Refer to electrical diagrams for additional ground connection requirements.
- H. Cabling groups and conduit separation:
1. Refer to “CABLING GROUPS AND CONDUIT SEPARATION SCHEDULE”.
- I. Firmly secure all equipment in place that is not intended for portability.
- J. Mount projectors permanently and provide mechanical index ensuring precise alignment of the projected image.
- K. Provide adequate structural support for AV system components. Provide fastenings and supports with a safety load factor of at least five.

3.2 LABELING

- A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and wall plates. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
- B. All labels shall meet UL 969 requirements for legibility, defacement and adhesion requirements. Handwritten labels are not allowed. All labels shall maintain consistent typeface, size and color.
- C. Provide laminated plans (minimum size 11x17) of all AV as-built plans (including riser diagrams) in each and every AV Rack.

3.3 CONTROL SYSTEM FUNCTIONALITY:

- A. GENERAL:

1. All programming shall be turned over to owner after 1 year and all final changes have been made to the system. Passwords shall be removed from the program at this time.
 2. All common and most used functions shall be accessible with no more than 3 button presses. All GUIs for each type of space shall have a consistent look, feel and ease of use.
- B. ROOM FUNCTIONS:
1. Refer to drawings for keypad layouts, button callouts and description of system intent.
 2. All room controls are required to have the similar looks and functionality.
- C. Amplifiers shall be set to go to stand by after 30 minutes of no audio detection.

3.4 CYBER SECURITY

- A. Contractor shall change all default user-name and passwords for all network devices provided.
- B. No written username or passwords shall be located in any areas of installation.
- C. Use best industry practices to secure network and devices provided by contractor and associated with system.

3.5 FIELD QUALITY CONTROL:

A. TESTING:

1. Refer to Appendix A, "INTEGRATOR VERIFICATION CHECKLIST", for system verification requirements. Verification checklist shall be complete prior to final commissioning.
 2. Upon completion of installation of each system and after electrical circuitry has been energized, demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units on site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with testing.
 3. Before inspection by owner and AV Consultant, and after completion of the installation, conduct system tests and make necessary corrections for proper system operation.
 4. Adjust, balance and align equipment for optimum quality and to meet the manufacturer's published specifications.
 5. All limiters and/or compressors shall be set to prevent operators from over-adjusting sound levels and damaging system components, while maintaining the highest amount of gain possible.
 6. System shall have no audible hum, noise, RFI, or distortion when operating under normal conditions. System shall reproduce material at the loudspeakers rated output level without audible distortion. All input levels shall be pre-set so system may be operated without causing unstable feedback under normal use.
1. System shall have no image distortion, hum bars, color shift, or any other picture distortion while operating under normal conditions. Provide cable equalizers or an HDBaseT video solution. Cable equalizer shall be located near display and powered, on all cables that are more than 30 feet in length or with more than four (4) connection points. Refer to section 2.3.B in this specification for a list of pre-approved equipment. Adjust gain controls for optimum signal-to-noise with 0 dBu at a line-level input.
 2. Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color coding.
 3. Loose parts and poor workmanship or soldering shall be replaced.

4. Sweep Loudspeaker systems with high-level sine wave or 1/3 octave pink noise source. Correct causes of buzzes or rattles related to Loudspeakers or enclosures. Notify owner of external causes of buzzes or rattles.
 5. Equalize the loudspeakers to produce less than 6 dB total variation between 500 Hz and 8000 Hz (+/- 3 dB).
 6. Contractor shall provide system testing as described herein using up-to-date and industry accepted test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1. AV Contractor shall own and have access to a handheld Quantum Data 780C tester to allow for on-site verification testing and troubleshooting of HDMI and digital video networks and analog video displays. All test equipment used shall be factory calibrated within one year of use with references set daily prior to testing.
 7. Contractor shall provide HDCP compliant device with digital cables, and digital HDCP content for testing of routing and HDCP compliant distribution and switching. Also provide analog VGA output equipment for testing of video switching, scaling, and distribution if analog is included with this project.
 8. Horizontal cabling contractor shall test all twisted pair cabling used within the AV system following the standards in specification 27 1500 under the testing section. Provide documentation of testing to AV Consultant prior to final walk through.
- B. At the time of final commissioning, if the AV consultant determines that the systems are not sufficiently complete to do a final punch list, and was not notified at least three (3) days prior to the visit, then a return visit will be required. The AV Consultant's return visit will be paid for in advance by the AV integrator at a flat rate of \$500 per person, at no cost to the owner.

1.2 OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.

1.3 TRAINING:

- A. Provide two (2) sessions of one (1) hour each of training on the operation of each system, at job site, at no cost to owner.
- B. Training shall be recorded using a handheld video camera and professional microphone. Recording using a cell phone camera and microphone will not be accepted and will not count as a training. Two (2) DVD copies shall be given to the owner.
- C. The second training shall take place within a month of the first training and all questions shall be answered.
- D. Contractor shall be present at the first performance using the system. Owner will coordinate with contractor 3 weeks in advance for personal trained on the system to help with the show and be onsite in case there are any problems. AV Contractor to provide this within their bid.

1.4 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

END OF SECTION 27 4100

SECTION 28 23 00

IP VIDEO SURVEILLANCE SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division-26 Specification sections, apply to work of this section.
- B. Division-26, 27 & 28 basic materials and methods sections apply to work specified in this section.
- C. Refer to specification 26 0553 for cabling, conduit and junction box color requirements.
- D. Refer to specification 27 1500 for category and/or optical fiber cable and connectivity specifications and installation standards.
- E. All unshielded category 'UTP' and/or optical fiber cable, for security equipment, used on this project shall match the horizontal cabling within the building.
- F. **Definitions:**
 - 1. VMS – Video Management System
 - 2. NVR – Network Video Recorder
 - 3. IP – Internet Protocol
 - 4. PTZ – Pan Tilt Zoom
 - 5. PoE – Power Over Ethernet
 - 6. LPR – License Plate Recognition
 - 7. IR – Infrared
 - 8. WDR – Wide Dynamic Range
 - 9. MFR – Max Frame Rate
 - 10. IP Rating – Weather/Environment Rating
 - 11. IK Rating – Vandal Resistant Rating
 - 12. AD – Active Directory
 - 13. UI – User Interface
 - 14. UPS – Uninterruptible Power Supply
 - 15. RAID – Redundant Array of Independent Disks

1.2 ADMINISTRATIVE REQUIREMENTS:

BNA Project Contact(s):

Brian Anderson
Phone: 801-532-2196
Email: banderson@bnaconsulting.com

Dan Varney
Phone: 801-532-2196
Email: dvarney@bnaconsulting.com

1.3 DESCRIPTION OF WORK:

- A. Provide a complete and operating IP Video/Camera Surveillance System as shown in plans. System shall be complete with cameras, network video recorder, protective enclosures, lenses, mounting hardware, wiring normally and reasonably required for the operation of a complete for a complete and fully functioning IP video surveillance system.
- B. Cameras to be placed on the exterior of the Ice Support and Coffee Shop buildings and on poles around the ice skate rink for the safety of the patrons and property of the Millcreek Commons site.
- C. One license plate recognition camera to be placed on the pole at the main entrance to capture license plates on playback of video. Security integrator is expected to program camera's shutter speed to optimize license plate capture day and night. The camera does NOT need to log license plates in a database, however will need to be able to read a plate on playback.
- D. Provide programming so the City of Millcreek has access to live and recorded video at other city locations. Video will be stored locally on a Network Video Recorder located at the Ice Support Building's Telecommunications Room.
- E. Cameras to be programmed to perform optimally in challenging lighting conditions. Verify camera views with owner during final commissioning.

1.4 Bid Submittal:

- 1. Equipment Costs: Breakout cost of material and labor as different line items.
- 2. All submittals shall be submitted in a digital format with bookmarks for each section of equipment. Any submittals that are partial or incomplete shall be rejected and count as one submittal against the submittal allowance. No hand-written documentation is allowed.
- 3. Provide a complete bill of materials for all components, accessories and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
- 4. Submit manufacturer's data sheets and installation details for all devices, panels, cables and head-end equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
- 5. Submit manufacturer certifications for all systems provided. Certifications must be from local office providing the install.

1.5 Coordination:

- 1. Coordinate final inspection of the systems installed, with owner, three (3) weeks in advance.
- 2. Obtain GANTT chart for construction time frame from the General Contractor.
- 3. Coordinate with owner and electrical contractor PRIOR to rough-in to coordinate exact location of end devices.
- 4. Meet with electrical contractor prior to pathway rough-in to coordinate system requirements in each area.
- 5. Coordinate meeting with owner's IT Department prior to ordering equipment to verify IT requirements and standards.
- 6. Coordinate color and finish of all camera components with architect or electrical contractor as appropriate.
- 7. Notify engineer of any modifications between contract documents and submittals. It is the contractor's responsibility to ensure compliance with the documents.

8. Coordinate all interfaces needing 120VAC with owner and electrical contractor.
9. Provide a dedicated 20-amp circuit for Network video recorder.
10. Electrical Contractor to provide 120VAC to all equipment requiring power.

1.6 QUALITY ASSURANCE:

- A. **MANUFACTURERS:** Firms regularly engaged in manufacturing of security system equipment and components of the types described here-in and whose products have been in satisfactory use in similar applications for not less than 5 years.
- B. Bidders wishing to provide equipment other than the equipment specified shall submit proposed substitute equipment to Project Leader (8) working days prior to bidding. Submittals for prior approval shall include description of equipment, design intent, complete riser diagrams for proposed equipment, equipment specifications, cut sheets of proposed equipment, reason for alternate equipment. Project Leader may request physical equipment to test and demo. Acceptance of proposed equipment by owner shall not relieve security contractor from responsibility to provide systems equal to those specified in this Section. Contractor shall be ultimately responsible for providing complete and working system that function, control and operate in the same manner as the specified equipment. Owner has final say if proposed equipment is equal to the specified equipment. Equipment that owner is not familiar with will require the contractor to provide manufacturer training at manufacturer's facility and have a manufacturer representative present at time of commissioning.
- C. **INSTALLER:**
 1. Integrating firm shall have worked satisfactorily for a minimum of (5) years of completing systems equal to this scope, quality, type and complexity.
 2. Key personnel assigned to the project shall each have minimum of (5) years of experience in completing systems equal to this scope, quality, type and complexity.
 3. Contractor shall be a factory authorized installer of all equipment specified for the geographical area of the project.
 4. Contractor shall maintain complete installation and service facilities for the duration of the project contract.
 5. Contractor shall have current manufacturer certifications for all security systems and equipment listed within this specification. Certifications must be from local office providing the install.
 6. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry best practices concerning grounding, shielding, cable dressing, cable termination and equipment mounting.
 7. All technicians are required to have proper state licensing to perform work within this specification.
- D. **PRE-APPROVED INSTALLERS:**
 1. Identisys
- E. **Bidders not pre-approved:** Bidders that are not on this pre-approved list shall submit in writing the following for review at least (8) working days prior to bid.

List of qualifications include:

1. Industry and manufacturers certifications.
2. Past and current projects within the last 5 years similar in scope and size.
3. (3) Different referrals from the owners of (3) different projects within the last 5 years.

1.7 SUBMITTALS:

- A. The following items shall be included in the shop drawings submittal. Submittals to be reviewed and approved prior to ordering equipment.
1. All submittals shall be submitted in a digital format with bookmarks for each section of equipment. Any submittals that are partial or incomplete shall be rejected and count as one submittal against the submittal allowance. No hand-written documentation is allowed.
 2. Provide a complete bill of materials for all components, accessories and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
 3. Submit manufacturer's data and installation details for all devices, cameras, network switches, servers / work-stations, cables and head-end equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
 4. Submit dimensioned drawings and device wiring layouts for all equipment.
 5. Submit equipment rack elevation diagrams (if applicable).
 6. Submit network switch port count and power requirements. Port count and POE switch requirements should be broken out per IDF/MDF closet.
 7. Submit manufacturer certifications for all systems provided. Certifications must be from local office providing the install.
- B. Provide the Owner the following upon project completion:
1. A complete set of shop drawings indicating: Locations of all cameras, network switches and servers / work-stations; point-to-point wiring diagrams for all devices.
 2. A complete equipment list identifying: Type; model; manufacturer; manufacturer's data sheets.
 3. A list of IP and MAC addresses, username and passwords for network devices coordinated with camera name and/or location.
 4. Serial and model numbers for all major components.
 5. Installation manuals and user manuals for all systems listed in these specifications.

1.8 WARRANTY:

- A. Systems shall be guaranteed for a period of one (1) year from the date of substantial completion against defective materials, inferior workmanship or improper installation adjustment. Guarantee shall cover all parts and labor.
- B. If system failure causes system to be inoperative or unusable for its intended purpose, contractor, when notified of the problem, shall repair system so it will be operational and usable within three (3) business days. If defective components cannot be repaired in time, provide temporary equipment as required.
- C. Systems designed for 24/7 operation shall be repaired and/or replaced within 24 hours of time of notification. If defective components cannot be repaired in time, provide temporary equipment as required.
- D. Contractor shall supply (1) year warranty on all system programming from the date of substantial completion. During this time period, upon owner request, the contractor shall

- provide programming changes up to (4) four times or 4 hours free of charge.
- E. Contractor shall honor equipment warranties for term established by manufacturer if greater than warranty time frame mentioned above.

PART 1 - PRODUCTS

1.2 Authorized Manufacture(s):

- A. Panasonic – Video Insight
- B. Axis Communications

1.3 NETWORK VIDEO RECORDER (NVR)

1. Provide video management software to include all camera licensing fees and software upgrade agreements for a minimum of 1 year. Install and configure all software on the network video recorder and workstations as required for owner use.
2. Provide all camera licensing fees and software upgrade agreements for a minimum of **1 year**. Install and configure all software on up to 3 owner provided workstations as required for owner use.
3. Setup motion masking on any outside trees or non-critical areas. (Verify with owner or consultant)
4. Set-up any user required privacy masking for personal areas information sensitive areas.
5. Contractor to set-up VMS mapping feature to show locations of cameras.
6. Contractor shall set up desired views and layouts of per owners' specifications.
7. Cameras to be set at 15 FPS when motion is detected, and record 1 FPS continuously.
8. Adjust motion recording and compression to optimize storage.
9. Contractor to ensure all software is on the latest firmware and version of video management software.
10. Install and program any specified analytics and optimize for cameras environment.
11. Contractor to verify all video storage on network video recorder be recorded a separate drive than main operating system drive.
12. Name all cameras and views per owner's requirements.
13. Install head-end equipment in the telecommunications rack located in the Ice Support Building.
14. Provide (1) NVR-R-1-12TB-A-V2 12TB Video-Insight network video recorder with internal storage capable of storing video a minimum of 30-day period or more, 24 Hours a day. Motion should be anticipated at 40%. Storage calculation should be based on cameras noted in drawings.
15. The computers operating system (OS) and VMS software shall be on a separate hard drive than the video storage recordings.
16. The system shall allow archiving to be enabled on a per camera basis and allow the user to define which archiving drive shall be used for each camera. The Hard Disk Drive storing the Archive Database.

17. The NVR shall have dual Network Interface Cards (NIC) and support connection to the cameras on a network separate from owner's network.
18. The Recording Server shall have the ability to accept the full frame rate supplied by the cameras, while recording a lower frame rate, yet still make the higher frame rate available to the Clients for live viewing.
19. The NVR and networking equipment supporting the NVR and camera POE switches must be protected from power spikes and brief power failures by an Uninterrupted Power Supply (UPS). The UPS should provide approximately 15 minutes of runtime at full load and should be rack mountable.
20. The server must be provided with (1) short depth rackmount LCD monitor with keyboard drawer.
21. Contractor is to program the system, and train the authorized personnel how to perform all necessary functions of the video surveillance system.
22. Provide server calculations from Video Management System provider and camera manufacturer to validate proper server configuration and hard drive storage in submittals.

1.4 Authorized Camera Manufacture(s)

- A. Axis Communications
 - B. Panasonic
- A. The cameras specified shall be designed for surveillance and industrial applications. The camera shall be high resolution, fully automatic, color camera capable of providing high resolution video over an IP LAN/WAN network.
1. The camera shall be fully supported by the VMS manufacturer.
 2. The camera shall have edge storage capability with removable SD card.
 3. The camera shall, at a minimum, be capable of providing a H.264 video stream 30 frames per second.
 4. The camera encoding rate shall be selectable from 1 to 30 frames per second in all resolutions.
 5. The camera must be capable of providing an RTSP video stream.
 6. The camera shall be designed to support Power over Ethernet (PoE) using UTP Category 6 or better cable with RJ45 connectors when an IEEE802.3af compliant switch is utilized.
 7. The contractor, based on the site visit, Security Plans and evaluated by owner, will submit proposed lens selection for each camera for written acceptance.
 8. All cameras are denoted by subscript on plans.
 9. Camera housings in the interior of the facility shall be ceiling mount type housings, which will match the general design of the building. All camera housings will entirely enclose wirings and cameras and be tamper proof.
 10. Exterior cameras shall have weatherproof enclosures regardless of location. They may be either dome or other environmental housings which suits the general appearance of the facility. All housings will entirely enclose wiring and cameras and be tamper proof.
 11. Exterior IP Cameras transmission lines must protect against lightning and other related power surges.
 12. Coordinate all camera locations, wiring, and rough-in requirements with owner and supplier prior to rough-in.

13. The camera shall be equipped with (1) 100BASE-TX Fast Ethernet port or faster, using a standard RJ-45 socket and shall support auto negotiation of network speed (100 Mbps and 10 Mbps) and transfer mode (full and half duplex)
14. Camera shall be powered via PoE or PoE+.
15. Provide camera types and quantities as indicated on the associated drawings.

B. Identification:

1. Identify cables at each end with a permanent label or physical/electronic tag.
 - a. The same alphanumeric identifiers should be used at both ends of the cable.
 - b. Identify cables at regular intervals throughout and wherever they are accessible.
 - c. Cables shall be identified in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate that can be accessed by removing the cover plate and to the cable behind the patch panel on a section of cable that can be viewed without removing the bundle support ties. Cables labeled within the bundle where the label is obscured from view shall not be acceptable.

PART 3 – EXECUTION

3.1 INSTALLATION OF IP VIDEO / CAMERA SURVEILLANCE SYSTEMS:

- A. Install all IP cameras at locations shown on drawings and after conducting a walk-through with the owner to verify exact locations. Install NVR and all power equipment to provide a fully functional system.
- B. Coordinate all cabling work, patch cabling and labeling with owner and Division 27 contractor.
- C. Contractor shall configure camera frame rates, resolutions, and IP addressing of cameras.
- D. Contractor shall be responsible for coordinating work with owner and the IT staff to coordinate devices on network specific to the video surveillance system.
- E. Program all cameras to be recording at 1 frame per second continuously. Upon motion detection, cameras to record at 15 frames per second.

3.2 SYSTEM CONFIGURATION PROGRAMMING

- A. Configure the system for full operation. Include owner in the process as much as feasible to understand their intended operation and insure full transfer of operations to them.
- B. Provide a fully commissioned system to ensure the entire system is operating as intended and in accordance with Owner policy. Label cables on both ends in all boxes, panels and racks according to Owner standards.

3.3 CYBER SECURITY

- A. Contractor shall change all default user-name and passwords for all network devices provided. A Strong Password **should** -
 1. Be at least 8 characters in length

2. Contain both upper and lowercase alphabetic characters (e.g. A-Z, a-z)
 3. Have at least one numerical character (e.g. 0-9)
 4. Have at least one special character (e.g. ~!@#\$%^&*()_-=)
- B. No written username or passwords shall be located in any areas of installation.
- C. Network devices to be set up on a separate network other than owner's LAN ensuring no internal or external users can access system without authorization.
- D. Follow manufacturers hardening guide and use best industry practices to secure network and devices provided by contractor and associated with system.
- E. No equipment in this specification shall contain Huawei / HiSilicon chips or any other equipment deemed a cyber security risk on the owners' network.

3.5 OPERATING AND MAINTENANCE MANUALS:

- A. Operating and maintenance manuals shall be submitted prior to testing of system. Total of two (2) manuals, shall be delivered to the owner. Manuals shall include all model numbers, service, installation, and programming information. All information must be bookmarked with a table of contents.
- B. Include all the following information:
1. Warranty
 2. Network settings (IP & MAC Addresses)
 3. User name and passwords
 4. Riser diagrams from Shop drawings
 5. Training videos
 6. USB Flash drive with programing source code and software editing programs.
 7. Installers and manufacturer contact information.

3.6 RECORD DRAWINGS:

- A. The Owner shall provide electronic (DWG) format of the video surveillance system drawings that as-built construction information can be added to. These documents will be modified by the security contractor to denote as-built information as defined above and returned to the Owner.
- B. Provide a complete set of CAD as-builts are expected to be maintained during project installation (progress-set) and submitted upon final completion. These as-builts shall show wire paths, final device location, color coding, specific interconnections between all equipment, and internal wiring of the equipment and any changes to the configuration of the original construction drawings. No hand written as-built documentation is allowed. Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) to owner.

3.7 TRAINING:

- A. Contractor shall provide a minimum of two sessions of (4) hours of on-site training at no cost to the owner on the operation, installation, and maintenance of this IP Camera/Video Surveillance System. And ensure the owner is proficient in understanding how to use, run, and program this system, with the contractors contact information readily available.
- B. Contractor shall provide a 3-month follow up review with the owner and provide 2-hours training if needed.

END OF SECTION 28 2300

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SECTION 28 3111

FIRE ALARM AND DETECTION SYSTEM

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 work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. Provide a separate, stand-alone system for each building.
- B. Extent of fire alarm and detection systems work is indicated by drawings, schedules and as specified herein.
- C. Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories. Provide components and systems that are UL-listed and labeled for fire alarm. Provide fire alarm and detection systems and accessories that are FM approved. Comply with State and local requirements as applicable.
- D. Comply with applicable provisions of current NFPA Standards 72, National Fire Alarm Code, local building codes, and meet requirements of local authorities having jurisdiction.
- E. Carefully review all Division 23 drawings for all fire/smoke dampers. Fire/smoke dampers are NOT shown on electrical plans. Electrical contractor is responsible for coordinating 120V power to all dampers and providing fire alarm connections to each one. See mechanical drawings for all locations.

1.3 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. MANUFACTURER: Subject to compliance with requirements, provide fire alarm and detection systems of one of the following:
 - 1. Grinnell
 - 2. EST
 - 3. Gamewell - FCI
 - 4. Simplex (Tyco Safety Products)
 - 5. Mirtone
 - 6. Mircom
 - 7. Notifier
 - 8. Silent Knight
 - 9. Siemens Fire
- B. The job foreman or lead technician shall be factory trained and certified on the system being installed. Individual shall have a minimum NICET II certification.

2.2 FIRE ALARM AND DETECTION SYSTEMS:

- A. GENERAL: Provide an electrically operated, electrically supervised fire alarm system as described herein. Include control units, power supplies, alarm initiating and indicating

devices, conduit, wire, fittings and accessories required to provide a complete operating system. Enclose entire system in raceway. Provide basic wiring materials that comply with Division 26, Basic Materials and Methods Sections for raceways, conductors, boxes, fittings, supports, etc. Minimum wire size to be #14 AWG copper.

- B. SYSTEM TYPE: Analog addressable, non-coded. Either manual activation of a fire alarm station or activation of an automatic initiating device energizes all fire alarm signaling devices, sounding a non-coded alarm and providing device identification on an annunciator panel.
- C. SYSTEM OPERATION: Provide system such that any manual station or automatic initiating device annunciates all alarm indicating units (bells, horns, buzzers, chimes, visual alarm lamps, etc.) continuously until the manual station or initiating device is restored to normal and the fire alarm control unit reset. Annunciate alarm signals by device at the control panel and all remote annunciators. Provide all conductors, raceway, equipment and labor to accomplish the following:
 - D. For fans that are not part of the smoke evacuation system, deactivate air supply and return fan units simultaneously by means of a supervised master fan shutdown relay with slave relays as required. Restart air units automatically after panel has been reset. Provide a bypass switch for master fan shut down relay for drill purposes, and indicate by a locked-in lamp that the circuit has been bypassed.
 - E. Selectively activate and/or deactivate fan units as required.
 - F. Release all magnetic door holders upon activation of an alarm from any device by use of a master relay in the control panel.
 - G. Provide supervised circuits for the following:
 - 1. Close dampers upon activation of an alarm from any device through the HVAC interface relays at the Fire Command Center.
 - H. Central Station Monitoring. Provide a UL listed fire control communicator in accordance with NFPA 71 with a minimum of two reporting zones to the central station. Provide a communicator with dual phone lines for central station reporting by using BFSK or pulsed single round fast format. Provide integral trouble annunciator. Provide with compatibility for automatic test reports every 24 hours. Provide system and components that comply with UL 2635 and UL 864.
 - I. Provide fire alarm control panel with capability of shutting down individual initiating devices for maintenance purposes without affecting the continued operation of other initiating devices.
 - J. Provide manual fire alarm stations in boiler rooms, and main administrative office. Provide external alarm horns sufficient to be heard in all parking areas.
 - K. Sprinkler Supervision. Provide a signal initiating and supervisory circuit to each PIV (post indicator) valve, and to each sprinkler riser and subdivision. Provide continuous alarm signal upon actuation of any water flow signal initiating device. Sound alarm until the condition has been corrected and the panel manually reset as required by UL864. Provide separate alarm zones for: (1) alarm zones from "waterflow alarms", (2) alarm zones from "supervisory alarm" indicating sprinkler system trouble. Provide power to all alarm bells furnished under Division 21 Review final fire sprinkler drawings and coordinate for panel, flow and tamper switch locations.
 - L. Provide relays, monitor modules and connections as required at control panel of kitchen hood suppression system for initiation of alarm signal to fire alarm control panel. Connect hood suppression control panel to shunt trip breakers as required.
 - M. Provide all required wiring from gas shut off valve to the hood suppression control panel. Make all connections to ensure a properly operating system. Verify with Mechanical Contractor.

2.3 SCOPE OF THE WORK:

- A. Provide a new addressable fire alarm system with 08 ANALOG initiating loops/minimum of 500 points.
- B. Provide all fire alarm devices.
- C. Provide duct smoke detectors and fan relays at all fan units 2000 CFM and over. Shut down all supply and return fans upon a general alarm signal.
- D. Provide a fire alarm duct detector within 5-feet of any fire/smoke damper as required to comply with IMC 607.5.4.1. The duct detector shall be listed for the air velocity, temperature and humidity at the point where it is to be installed. A duct detector will not be required at a fire/smoke damper located on a corridor wall where the corridor has smoke detection devices installed. For dampers installed within an un-ducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 5-feet horizontally of the damper. Provide a fire alarm relay at each fire/smoke damper. Provide a test switch at each location where the damper is located above an inaccessible ceiling or is located more than 10 feet above the finished floor. Coordinate the location of test switches with owner/architect.
- E. All initiating devices connected to the fire alarm control panel shall be analog addressable.
- F. All wiring shall be in conduit (3/4" minimum). All conduit and connectors, shall be made of steel. All conduit runs shall form a complete loop from the fire alarm control panel.
- G. Provide vandal resistant cages to protect horn/strobes, smoke and heat detectors as indicated and, in gyms whether shown or not. Securely fasten security cages as required. Provide backing and bracing as required to ensure that attachment extends beyond the ceiling materials. Cages shall have two pieces, one backplate and one cover to attach to backplate.
- H. Provide Carbon Monoxide Detectors in the first room downstream from a fuel burning Roof Top Unit and in spaces that have fuel burning appliances, ie: Kitchen Equipment, dryers, Boilers, water heaters, Kilns Etc.

2.4 FIRE ALARM CONTROL PANEL:

- A. The fire alarm control panel shall be microprocessor-based. Each loop shall be capable of 99 analog addresses and 98 monitor and/or control addresses.
- B. If the microprocessor fails, the system shall execute a default signaling program. This program will enable the panel to sound the audible signals and summon the Fire Department. In addition, a red LED shall light to indicate the device wherein the alarm originated. Inability of the system to sound signals or summon the fire department during microprocessor failure shall not be acceptable.
- C. The fire alarm control panel shall contain a 80 digit alphanumeric display and permit the user to perform all necessary functions including but not limited to the following:
 - 1. Alarm/Trouble Acknowledge
 - 2. Alarm Silence
 - 3. Reset
 - 4. Lamp Test
 - 5. Control of Initiating Devices (on/off)
 - 6. Control of output modules (on/off)
 - 7. Change sensitivity of devices
 - 8. Change time
 - 9. Walk test

10. Check system on battery voltage and current
- D. The fire alarm control panel shall be capable of alarm verification. The control panel shall indicate which smoke detector is in alarm during the pre-alarm window.
- E. All alarm signals shall be locked in at the panel until the operated device is returned to its normal condition and the control panel is manually reset.
- F. Alarm or trouble activation of initiating points shall be represented in English on the alphanumeric display on both the remote operating panel and the fire alarm control panel indicating the address of the specific device, i.e. Device L4S76, Smoke Detector, 1st floor Rm. 17.
- G. Each initiating and signal circuit shall be electrically supervised for opens, shorts, and ground faults in the wiring.
- H. The occurrence of any fault shall activate the system trouble circuitry but shall not interfere with the proper operation of any circuit that does not have a fault condition.
- I. The system communication loops shall be capable of being wired using Class "A" (Style 6) supervised circuits (a ground fault on either conductor or a break shall not prevent a device from operating on either side of the break)
- J. The fire alarm control panel shall contain circuitry permitting the transmission of trouble and alarm signals over leased phone lines by the means of reverse polarity. There shall be a supervised disconnect switch to allow testing of the fire alarm control panel without transmitting an alarm to the central station.
- K. The fire alarm control panel shall include the following features:
 1. Auxiliary SPDT alarm actuated contacts.
 2. Auxiliary SPDT trouble actuated contacts.
 3. A solid-state power transfer circuit that shall switch to standby power automatically and instantaneously if normal power fails or falls below 15% of normal ("brown out" conditions). This electronic circuit shall allow the batteries to be effectively "floated" on the operating system to avoid upsetting the normal microprocessor scan and minimize resultant nuisance troubles and/or alarms.
 4. A ground fault detector to detect positive or negative grounds on the initiating circuits, signal circuits, power circuits, and telephone line circuit. A ground fault code on the alphanumeric display shall provide indication of either a positive or negative ground fault and shall operate a general trouble but shall not cause an alarm to be sounded
 5. A short circuit error message shall be a standard feature of the fire alarm control panel. Each communication loop shall be monitored and shall have a distinctive error message.
 6. Lightning protection shall be a standard feature of the fire alarm control panel and shall be incorporated in the power supply circuit, common control circuits, signal circuits, and telephone line circuit.
 7. Individual circuit breakers shall be provided for the following: smoke detector power, main power supply, signal circuit #1, signal circuit #2, battery standby power, and auxiliary output.
 8. The fire alarm control panel shall be of dead-front construction. One key shall allow access to all electronics or to the dead-front access to the operator functions
 9. Opening the main door shall expose all components for inspection or adjustment without further dismantling of the cabinet, control unit, or wiring.
 10. It shall be possible to check and adjust the sensitivity of all analog devices from the main fire alarm panel.
- L. The fire alarm control panel shall have batteries capable of powering the system for (24)

hours in standby condition and (5) minutes in alarm.

- M. There shall be no special tools required for the programming of devices. A standard slot head screwdriver only.

2.5 REMOTE OPERATING PANEL:

- A. Remote Operating Panel (Provide color as selected by Architect)
- B. The Remote Operating Panel shall contain 80-digit alphanumeric display providing status of all devices including the fire alarm control panel.
- C. The Remote Operating Panel shall permit the user to perform all necessary functions including but not limited to the following:
 - 1. Alarm/Trouble Acknowledge
 - 2. Alarm Silence
 - 3. Reset
 - 4. Lamp Test
 - 5. Control of Initiating Devices (on/off)
 - 6. Control of Output Modules (on/off)
 - 7. Change sensitivity of devices
 - 8. Change time
 - 9. Walk test
 - 10. Check System on battery voltage and current

2.6 MONITOR MODULE (FCI AMM-2):

- A. Remote identification module devices shall be attached to any single normally open initiating device (heat detector, waterflow switch, duct detectors, sprinkler, tamper switches, kitchen hood, pull station, etc.). The modules shall supply addressing and status information to the Fire Alarm Control Panel through the dual loop module.

2.7 CONTROL POINT MODULE (FCI AOM):

- A. The control point module shall be connected to the same loop as the initiating devices, and shall provide a relay output (Form "C" 2 Amp @ 24 VDC, resistive only).
- B. This relay output shall be used to perform auxiliary functions.
- C. When the AOM is activated, the red "ACTIVE" LED shall be on solid. Under normal conditions, the red "ON LINE" LED shall flash.

2.8 MANUAL FIRE ALARM STATION (FCI, MS-2, W/AMM-2):

- A. Provide red enclosure, manual fire alarm stations with the following features:
 - 1. Aluminum construction, for flush mounting.
 - 2. Addressable alarm type electrically compatible with system requirements.
 - 3. Double Action
 - 4. Dual-Action design requiring unit to be opened for resetting, and requiring resetting before closing. Key reset, keyed like fire control panel.

2.9 PHOTOELECTRIC DETECTORS (FCI ASD-P W/ADB-F BASE):

- A. All photoelectric detectors shall be capable of being replaced without disconnecting any wires or wire connectors from the base of the detector. Each detector shall be installed on a separate base. The detector base shall be capable of receiving a photoelectric, ionization, or electronic thermal detector. All photoelectric detectors shall be UL 268 listed. All detectors shall have (2) viewable LEDs to indicate the status of the device.

2.10 DUCT FIRE DETECTORS (FCI DH500AC/DC WITH SAMPLING TUBE):

- A. Provide ionization type with UL 268A listings. Each detector shall be equipped with a remote light. Each detector shall have (2) form "c" alarm contacts rated at 10 amps (at 120VAC).

2.11 CARBON MONOXIDE (CO):

- A. Provide a System Sensor CO1224T carbon monoxide detector with Realtest Technology. Provide detectors with the following features:
 - 1. Compliance with UL2075.
 - 2. Trouble relay.
 - 3. Wiring supervision with SEMS Terminals.
 - 4. A six year end-of-life timer.
 - 5. Sounder base for sound audible alarm.

2.12 THERMAL DETECTORS (FCI ATD WITH/ADB-F BASE):

- A. Thermal detectors shall operate on the Rate-of-Rise principal. The detectors shall have a fixed temperature rating of 135 degrees Fahrenheit. Exception: in Boiler rooms, provide temperature rating of 200 degrees Fahrenheit.
 - 1. The heat detector shall consist of a base and a head.
 - 2. The base shall be capable of accepting either a smoke detector or a 135 (or 200) degree heat detector.
 - 3. The head shall automatically restore to its normal standby condition when the temperature returns to its normal range.

2.13 AUDIOVISUAL ALARM HORNS (FCI, HMF/STS SEMI-FLUSH MOUNTED OR EQUAL):

- A. Provide audio-visual alarm horns with the following features:
 - 1. Die cast or stamped steel construction, finished in red/white (color by Architect) enamel, suitable for indoor or outdoor application.
 - 2. Capable of 90 db (UL rating) sound level at 10 feet.
 - 3. Flush mounted
 - 4. Integrally mounted flashing light unit, with Lexan lens with block letters "FIRE", and minimum flash rate of ONE per second, and 110 candela minimum.
 - 5. Electrically compatible with system requirements.
 - 6. Horns shall sound the temporal pattern (code 3) until silenced.
 - 7. Audiovisual alarm horns shall have the ability to silence horns while maintaining the strobe flash, until reset.
 - 8. Mechanical horn mechanism only, electronic horns are not acceptable.
 - 9. Maximum 24 horns per circuit, maximum 8 strobes per circuit.
- B. Strobes shall be synchronized when there are three or more within sight and less than 55 feet of viewer.

2.14 STROBES (FCI Model STS, FLUSH MOUNT):

- A. Provide strobe with flashing light unit, with Lexan lens with block letters "FIRE", and minimum flash rate of ONE per second, and high intensity 110 candela minimum. Strobes shall be synchronized when there are three or more within sight and less than 55 feet of viewer. Furnish in Red/White (color by Architect).

2.15 AUXILIARY RELAY (FCI, ARB-C):

- A. Remote auxiliary relay boards shall be rated at 10 AMPS @ 120 VAC. A red LED shall light to indicate relay activation. All relays shall transfer on general alarm and latch on until reset. All relays shall be supervised. The control output provided can be used in conjunction with fire alarm applications (i.e. fan controls, dampers, doors, and any other general alarm control).

2.16 INITIATING MODULES:

- A. Provide style "6" initiating modules capable of receiving and annunciating an alarm from any detector, even with a single fault condition on any initiating circuit.
- B. Power all smoke detectors from the "Style 6" initiating loop wiring. For systems that power smoke detectors separately from the "Style 6" loop, provide monitoring for both the power source and the independent initiating wiring, so that complete trouble and alarm indication is achieved by loop. Provide capability to operate all smoke detectors, even with a single fault condition on the smoke detector power wiring. Provide one spare initiating circuit.

2.17 SIGNALING MODULES:

- A. Provide signaling as required. Provide power adequate to sound all signaling devices concurrently. Provide supervised indicating circuits for polarized 24V D.C. alarm signaling devices. Provide 2 spare signaling circuits.
- B. Each signal circuit shall have a separate disconnect switch for servicing the fire alarm system. Each and every indicating circuit shall have a distinct location description. Power supply shall be at fire alarm control panel. Remote power supplies and indicating circuits will not be acceptable.

2.18 SUPPLEMENTAL NOTIFICATION CIRCUITS (FCI SNAC-4):

- A. Provide supplementary notification appliance circuit panel(s) as required. The 'SNAC' shall be capable of supplying up to four, Class A, Style Z notification appliance circuits. The panel shall contain its own battery charger, regulated power supply, and shall be supervised for ground fault, overcurrent, open circuits and low battery conditions. Ground fault, battery and circuit trouble conditions shall transmit a trouble signal to the main fire alarm control panel.

2.19 SYSTEM CONFIGURATION PROGRAMMING:

- A. To help the owner in programming, system changes, and servicing, the fire alarm system shall have the following functions.
 - 1. The FACP shall be capable of an auto-configuration, that via a password, all analog devices and panel modules are automatically programmed into the system. At this point the system will operate as a general alarm system without any other programming.
 - 2. If any two devices are addressed the same, the LED's on both devices will light steady and the panel will read "extra address and the address number".
 - 3. If any device is installed and not programmed into the system the LED will light steady and the panel will read the same as above.

2.20 BATTERIES/POWER SUPPLIES:

- A. Provide standby batteries capable of operating fire alarm system for minimum of 24 hours, then operating all indicating units for at least five minutes. Locate batteries in fire alarm control unit, or in similar type enclosure located as directed. Provide all interconnecting wiring. Place batteries that vent hydrogen gas in separate enclosure. Provide 30 percent spare capacity.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

- A. Approved Plans: A copy of the approved and stamped plans shall be on site during the installation and at the time of inspection to verify that the system is installed according to the approved plans.
- B. Install fire alarm and detection systems as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "standard of installation".
- C. Install wiring, raceways, and electrical boxes and fittings in accordance with Division 26 Basic Materials and Methods section, "Raceways", "Wires and Cables", and "Electrical Boxes and Fittings", and in accordance with other sections, as applicable.
- D. All wire used on the fire alarm system shall be U.L. Listed as fire alarm protective signaling circuit cable per NEC, Article 760.
- E. If twisted or shielded wire is required or recommended by the manufacturer it must be used.
- F. Review proper installation procedure for each type of device with equipment supplier before installation.
- G. Provide a minimum of one 3/4" conduit with (2) Cat 5e telephone cables from FACP to main telephone terminal.
- H. Where smoke or heat detectors are specified, install device a minimum of three feet from adjacent air supply diffusers to ensure proper operation of device.
- I. Refer to NFPA for spacing and exact placement of fire alarm devices.
- J. Electrical Identification: Refer to Section 260553 for requirements.

PART 4 - FINAL ACCEPTANCE AND GUARANTEE

4.1 GUARANTEE:

- A. Furnish a three-year guarantee for all equipment, materials and installation, including all labor, transportation, and equipment.
- B. Emergency Response. The fire alarm equipment supplier shall provide an emergency response within four hours of any reported system failure to resolve the problem on a continuous basis.

4.2 PRE-TEST:

- A. The contractor shall with a representative of the manufacturer conduct a test 3 days before the final test to verify operation of all devices. Any problems must be corrected before the final test.

4.3 FINAL TEST:

- A. Before the installation shall be considered completed and acceptable, a test on the system shall be performed as follows:
 - 1. The contractor's job foreman, a representative of the manufacturer, a representative of the owner, shall operate every building fire alarm device to ensure proper operation and correct annunciation at the control panel. Fan shutdown and door holder circuits shall operate.
 - 2. Conduct a full 24-hour test of battery operation. System shall be put on the batteries for a full 24 hours and all notification appliances shall be operational for a period of 5 minutes.

The supervisory circuitry of the initiating and indicating circuits shall also be verified.

4.4 SPARE PARTS: Refer to Section 26 0502 for requirements.

PART 5 - AS BUILT DRAWINGS AND OPERATION AND MAINTENANCE MANUALS:

5.1 LABELING:

- A. All devices shall be labeled with their appropriate address. The labels shall be 18 point pressure sensitive labels.
- B. All initiating devices shall be programmed to include the device address and a complete user text English location description, i.e. Device L4S76, Smoke Detector, 1st floor Rm.17

5.2 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

5.3 OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.

5.4 TRAINING:

- A. Provide four (4) hours training on the operation and installation of fire alarm system, at job site, at no cost to owner. Provide programming training and software sub-licensing in owner's name. Sub-licensing agreement shall include the U.L. requirement to allow the owner to do any programming that the supplier is allowed to do during commissioning, testing, service and field additions or deletions to the fire alarm system. The fire alarm supplier shall provide this training and licensing at no cost to the owner, including transportation, lodging, meals, and training manuals.

END OF SECTION 28 3111

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SECTION 31 1000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above- and below-grade site improvements.
 - 6. Disconnecting, capping, or sealing site utilities.
 - 7. Temporary erosion and sedimentation control.
- B. Related Requirements:
 - 1. Section 01 5639 "Temporary Tree and Plant Protection."
 - 2. Section 32 9113 "Soil Preparation."

1.2 PREINSTALLATION MEETINGS

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

1.3 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

- E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 2000 "Earth Moving."
 - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 01 5639 "Temporary Tree and Plant Protection."
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site according to requirements in Section 01 5639 "Temporary Tree and Plant Protection."

- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 01 5639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Consultant not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Consultant's written permission.
- C. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 02 4119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 2. Use only hand methods or air spade for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 1000

SECTION 32 1316 - DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes colored and stained concrete paving.
- B. Related Requirements:
 - 1. Section 03 3001 "Cast-in-Place Concrete, Exterior" for specialty cast-in-place concrete.
 - 2. Section 32 1313 "Concrete Paving" for concrete paving with standard finishes, curbs and gutters, and stamped detectable warnings.
 - 3. Section 32 1373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and other paving or adjacent construction.

1.2 DEFINITIONS

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

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and decorative concrete paving construction practices.
 - 2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Decorative concrete paving Installer.
 - d. Manufacturer's representative of decorative concrete paving system.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type of exposed color, pattern, or texture indicated.

- C. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
 - 1. Installer for Scofield color, sparkle grain and acid finish shall be:
 - a. Qualified contractor with experience providing sparkle/metallic concrete with acid finish. Provide contractor experience and installed project examples within the last 5 years for owner and architect approval.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Curing compounds.
 - 4. Applied finish materials.
 - 5. Joint fillers.
- C. Material Test Reports: For each of the following:
 - 1. Aggregates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.

2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Consultant and not less than 96 inches by 96 inches.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Consultant specifically approves such deviations in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on decorative concrete paving mixtures.

1.8 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 1. ACI 301.
 2. ACI 117.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150/C 150M, Type II. Use one brand of cement throughout project, unless otherwise acceptable to Consultant.
 - 2. Fly Ash: ASTM C 618, Class F.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
 - 1. Maximum Coarse-Aggregate Size: 1-inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A and containing not more than 0.1 percent chloride ions.
 - 2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D and containing not more than 0.1 percent chloride ions.
 - 3. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F and containing not more than 0.1 percent chloride ions.
 - 4. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G and containing not more than 0.1 percent chloride ions.
 - 5. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
 - 6. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.
- F. Water: ASTM C 94/C 94M and potable.

2.4 SURFACE COLORING MATERIALS

- A. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
 - 1. Basis-of-design product: Provide color hardener based on the product named:
 - a. Lithochrome Color Hardener by Sika Scofield.
 - b. Pacific concrete products sparkle grain or equal. Provide cutsheet and sample for approval. (831) 457-4566.

2.5 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Polyethylene Film: ASTM D 4397, 1 mil thick, clear.

2.7 CONCRETE MIXTURES

- A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.
- B. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
- C. Cementitious Materials: Use fly ash, pozzolan, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

- D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
- E. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- F. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- H. Concrete Mixtures: Normal-weight concrete.
 - 1. Minimum Compressive Strength: 4000 psi at 28 days.
 - 2. Maximum W/C Ratio: 0.45.
 - 3. Slump Limit: 4 inches.
 - 4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

2.8 CONCRETE MIXING

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 2000 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.
- B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 2. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 30 feet unless otherwise indicated. Expansion joint adjunct to the ice ribbon must be a min. width of 1 inch.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- F. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating joint devices.
- G. Screed paving surface with a straightedge and strike off.
- H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven

floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.7 INTEGRALLY COLORED CONCRETE FINISH

- A. Integrally Colored Concrete Finish: After final floating, apply the finish indicated on the Drawings:

3.8 PIGMENTED MINERAL DRY-SHAKE HARDENER APPLICATION

- A. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surfaces according to manufacturer's written instructions and as follows:
 - 1. Uniformly apply dry-shake hardener at a rate recommended by manufacturer to match paving color required.
 - 2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
 - 3. After final power floating, apply the finish indicated on the Drawings:

3.9 SURFACE FINISHES

- A. For surface finishes where indicated on the Drawings, provide the following:
 - 1. Light Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
 - 2. Medium Broom Finish: Provide a medium finish by striating float-finished concrete surface 1/16- to 1/8-inch deep with a stiff-bristled broom, perpendicular to line of traffic.
 - 3. Light Exposed Aggregate Finish: Apply no finish retardant. Lightly wash surface to expose sand surface and lightly expose aggregate.
 - 4. Heavy Exposed Aggregate Finish: Apply evaporation retarder. Wash surface to expose aggregate to 1/8-inch deep.
 - 5. Light Sandblast Finish: Lightly sandblast surface to expose sand surface and lightly expose aggregate.
 - 6. Heavy Sandblast Finish: Sandblast surface to expose aggregate to 1/8-inch deep.

3.10 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Compound: Apply immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.
 - 1. Cure integrally colored concrete with a pigmented curing compound.
 - 2. Cure concrete finished with pigmented mineral dry-shake hardener with a pigmented curing compound.

3.11 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/2 inch.
 - 4. Lateral Alignment and Spacing of Dowels: 1 inch.
 - 5. Vertical Alignment of Dowels: 1/4 inch.
 - 6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
 - 7. Joint Spacing: 3 inches.
 - 8. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 9. Joint Width: Plus 1/8 inch, no minus.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 2,000 sq. ft. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

- a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Consultant, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Consultant but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Consultant.
- G. Decorative concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

- A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Consultant.
- B. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1316

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
 - 2. Joint-sealant backer materials.
 - 3. Primers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

2.3 JOINT-SEALANT BACKER MATERIALS

- A. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- B. Backer Strips for Cold-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Cleaning of Joints: Clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
- C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.
- D. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- E. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- F. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
 - 1. Place joint sealants so they fully contact joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- H. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- I. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

END OF SECTION 32 1373

SECTION 32 1400 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete pavers set in aggregate and mortar setting beds.

1.2 ACTION SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Sustainable Design Submittals:
- C. Samples: For each type of unit paver indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

1.4 FIELD CONDITIONS

- A. Cold-Weather Protection: 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 paver work damaged by frost or freezing.
- B. Weather Limitations for Bituminous Setting Bed: Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.
- C. Weather Limitations for Mortar and Grout:
 - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

- A. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936/C 936M and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.
- B. Basis-of-design product: Provide interlocking concrete pavers based on the product named:
 - 1. Stepstone large scale calarc pavers per drawings and details.
- C. Concrete Pavers
 - 1. Thickness: 2-1/2 inches.
 - 2. Face Size 8"x16", 12"x12", 12"x24".
 - 3. Color: As selected by Consultant from manufacturer's full range.

2.2 ACCESSORIES

- A. Felt Expansion Joint: 1/2" thick.
- B. Felt Expansion Joint: 1" thick adjacent to ice ribbon.

2.3 MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type II.
- B. Sand: ASTM C 33/C 33M.
- C. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
- D. Water: Potable.

2.4 MORTAR MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars if they have reached their initial set before being used.
- B. Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.
- C. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

- D. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- B. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- C. Joint Pattern: As indicated.
- D. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- E. Expansion and Control Joints: Provide felt expansion material at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

3.2 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.
- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- E. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch-thick bond coat to mortar bed or to back of each paver with a flat trowel.
- F. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
- G. Spaced Joint Widths: Provide 3/16-inch nominal joint width with variations not exceeding plus or minus 1/16 inch.
- H. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION 32 1400

SECTION 32 3300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Seating.
 - 2. Tables.
 - 3. Bicycle racks.
 - 4. Trash receptacles.
 - 5. Patio heater

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 SEATING - BENCHES

- A. Basis-of-design product: Provide backed bench based on the product named:
 - 1. Wood block bench type I by Timberform Colossus Giant.
 - 2. Movable wood block bench type 3 by Timberform with acrylic foot pegs.
 - 3. Movable wood block bench type 4 by Timberform with acrylic foot pegs.
 - 4. Wood blocks at steps/seatwall by Timberform custom install per plans and details.
- B. Backed Bench
 - 1. Materials
 - a. Wood block bench type 2 Colossus Giant 2219 by Timberform with backrest.
 - 2. Mounting: Surface mount per manufacture specifications, plans and details.

2.2 SEATING - CHAIRS

- A. Basis-of-design product: Provide chair based on the product named:
 - 1. Movable chairs by Maglin Kontur-ch. Pre-assembled solid steel, stackable chair color RAL 2009.
- B. Lounge Chair
 - 1. Landscape Forms Chill, freestanding movable.

2.3 TABLES - DINING

- A. Basis-of-design product: Provide dining table based on the product named:
 - 1. Movable Table Maglin Kontur Café Table, pre-assembled, solid steel with Umbrella Hole color: RAL 2009
- B. Dining Table:
 - 1. Size: 36 inch diameter.
 - 2. Height: Dining table, 30 inch height.
 - 3. Umbrella hole option: With umbrella hole.
 - 4. Mounting option: Movable
 - 5. Material: per manufacture specifications

2.4 TABLES - LOUNGE

- A. Basis-of-design product: Provide lounge table based on the product named:
 - 1. Stella Table by Landscape Forms.

2.5 BICYCLE RACKS

- A. Basis-of-design product: Provide bicycle rack based on the product named:
 - 1. Per plans and details.
- B. Bike Rack.
 - 1. Mounting:
 - a. Surface Mount (anchoring hardware not included).
 - 2. Materials:
 - a. Frame: Aluminum casting
 - b. Front and back covers: Aluminum castings
 - c. Hardware: two M4 x 0.7 x 12mm socket button head cap screws with Magni-coat secure the covers together.
 - d. Embedded Hardware Pack: (2) M12 x 1.75 threaded rod 120mm length, (2) M12 x 1.75 heavy hex nuts, (2) M12 flat washers, all carbon steel with Magni-coat.

3. Fabrication:
 - a. Shop assembled bicycle rack.
4. Finishes:
 - a. Finish on upper frame: Clear anodized
 - b. Finish on cover plates: Dark grey anodized

2.6 TRASH RECEPTACLES

- A. Basis-of-design product: Provide trash receptacle based on the product named:
 1. Landscape Forms Mult-De-EM-Hm-LL, Multiplicity – Double unit embedded multi use receptacle with hole and locks.
- B. Trash Receptacle:
 1. Single unit: Multi-use opening.
 2. Mounting: Embedded: Does not include rotomolded base. Includes (4) 3/8-16 threaded rods for embedding.
 3. Liner Color: Black.
 4. Options:
 - a. Locks. Keyed alike, 2 keys per lock.
 5. Materials:
 - a. Frame: cast aluminum.
 - b. Bin: Rotationally molded linear medium density polyethylene.
 - c. Lid: 6061 aluminum plate.
 - d. Bag Hanger: 304 stainless steel bar.
 6. Fabrication:
 - a. Shop assembled litter receptacles.
 7. Finishes on aluminum components:
 - a. Clear Anodized.
 8. Powder coat:
 - a. Landscape Forms, Inc. "Pangard II":
 - 1) Primer: Rust inhibitor.
 - 2) Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
 - 3) Test Results: "Pangard II":
 - a) Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
 - b) UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.

- c) Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
- d) Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
- e) Erichsen Cupping, ISO 1520: 8 mm.
- f) Impression Hardness, Buchholz, ISO 2815: 95.
- g) Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
- h) Pencil Hardness, ASTM D 3363: 2H minimum.
- i) Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max. undercutting 1 mm.
- j) Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max. blisters 1 mm.

b. Color per Drawings.

2.7 PATIO HEATERS

A. Basis-of-design product: Provide patio heater based on the product named:

- 1. Sunglo model PSA265V inground mount patio heater by Infrared Dynamics, Inc. order with vault option coordinate with manufacture to have heater shipped with vault option. Woodlanddirect.com (586) 430-5065

B. Patio Heater:

- 1. Height: 93 inches to heating element.
- 2. Width: Reflector, 34-1/2 inches diameter.
- 3. Spacing: 12 feet nominal.
- 4. Mounting: Embedded with vault box Tropic heating (949) 510-9600.
- 5. Materials:
 - a. Reflector: Deep disk circular type mounted on top of heater.
 - b. Infrared Radiant Emitter Grid: Perforated stainless steel.
 - c. Post: 3-inch diameter steel.
- 6. Fabrication:
 - a. Equipped with a control system for use with natural gas fuel.
 - b. Each heater shall have passed the ANSI requirements for outdoor heaters.
 - c. Equipped with a 100% safety shutoff device.
- 7. Operation:
 - a. Requires 24 VAC electrical to be connected to operate.
 - b. Utilizes an electronic ignition and monitors the heater through flame rectification.
 - c. Heater cannot be manually lit. Heater is turned off/on with electrical switch, timer, or other control device by interrupting the 24 VAC supply to the heater.
 - d. Control devise is to be supplied by the installer.

2.8 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- E. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.9 ALUMINUM FINISHES

- A. Powder-Coat Finish: If not an unfinished aluminum finish, provide the manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.10 STEEL FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.11 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run directional finishes with long dimension of each piece.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored or positioned at locations indicated on Drawings.

- D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
- E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
- F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

3.2 ADJUSTING

- A. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Consultant.
- B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Consultant.

3.3 CLEANING

- A. Clean site furnishings promptly after placement in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

3.4 PROTECTION

- A. Protect installed or placed site furnishings to ensure that, except for normal weathering, equipment will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 32 3300

SECTION 32 8400 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes a complete working and tested automatic sprinkler irrigation system for planting areas of the site.
- B. Existing and preserved landscape and hardscape areas disturbed shall be restored to original or better condition.
- C. Related Requirements:
 - 1. Section 31 2000 – Earthwork
 - 2. Section 32 9113 – Soil Preparation
 - 3. Section 32 9200 – Turf and Grasses
 - 4. Section 32 9300 – Plants
 - 5. Division 16 0000 – Electrical

1.2 SYSTEM DESCRIPTION

- A. Design of irrigation components: Locations of irrigation components on Construction Drawings may be approximate. Piping, sleeving and/or other components shown on Construction drawings may be shown schematically for graphic clarity and demonstration of component groupings and separations. Irrigation components shall be placed in landscaped areas, with the exception of pipe and wire in sleeving under hardscapes.
- B. Construction requirements: Actual placement may vary as required to achieve a minimum of 100% coverage without overspray onto hardscape, buildings or other features.
- C. Layout of Irrigation Components: During layout and staking, consult with Consultant to verify proper placement of irrigation components and to provide Contractor recommendations for changes, where revisions may be advisable. Small or minor adjustments to system layout are permissible to avoid existing field obstructions such as utility boxes or street light poles. Place remote control valves in groups as practical to economize on quantity of valve clusters. Quick coupler valves shall be placed with valve groups as shown on plans.

1.3 DEFINITIONS

- A. Water Supply: Piping and components furnished and installed
- B. to provide irrigation water to the Project. Including but not limited to nipples, spools, shut off valves, corporation stop valves, water meters, pressure regulation valves, and piping upstream of (or prior to) the Point of Connection.
- C. Point of Connection: Location where the Work ties into the water supply. May require nipples, spools, isolation valves, meter, back flow device, flow sensor, or stop and waste valve for landscape irrigation needs and use.

- D. Main line piping: Pressurized piping downstream of the Point of Connection to provide water to remote control valves and quick couplers. Normally under constant pressure.
- E. Lateral line piping: Circuit piping downstream of remote control valves to provide water to sprinkler heads, drip systems or bubblers.

1.4 REFERENCES

- A. The following documents or standards will apply to the work of this Section:
 - 1. ASTM – American Society for Testing and Materials
 - 2. IA – The Irrigation Association: Main BMP Document.
 - 3. ASIC – American Society of Irrigation Consultants: ASIC Grounding Guideline.

1.5 CONTRACTOR QUALIFICATIONS

- A. Provide document or resume including at least the following items:
 - 1. That Contractor has been installing sprinklers on commercial projects for ten previous consecutive years.
 - 2. Contractor is licensed to perform landscape construction in the State of Utah.
 - 3. Contractor is bondable for the work to be performed.
 - 4. References of five projects of similar size and scope completed within the last ten years. Three of the projects listed shall be local.
 - 5. Project On-site Foreman or Supervisor has at least five consecutive years of commercial irrigation Installation experience.
 - a. Project Foreman shall be a current Certified Irrigation Contractor in good standing as set forth by the Irrigation Association.
 - b. Project Foreman shall be on Project site 100% of each working day.
 - 6. Provide evidence that Contractor currently employs workers in sufficient quantities to complete Project within time limits that are established by the Contract.
 - 7. Provide list of employees to be assigned to this Project and their irrigation installation experience.
- B. Certifications: General laborers or workers on the Project shall be previously trained and familiar with sprinkler installation and have a minimum of one-year experience. Those workers performing tasks related to PVC pipe and electrical components shall have certificates designated below:
 - 1. Certified Irrigation Contractor.
 - 2. Workers engaged in handling, assembling and gluing of PVC pipe shall carry on Project site a Certificate of Training from the IPS factory representative authorizing said worker to prime and glue PVC pipe. (Contact Bill Godwin, G & S Sales, 801-972-0659).
 - 3. Workers engaged in the handling and installation of buried power wire, remote control valve wire, wire connectors, controllers and grounding equipment shall carry on Project site a Certificate of Training from Paige Wire factory representative authorizing said worker to install wire, wire connectors and grounding equipment. (Contact Vince Nolletti, Vice President Irrigation Operations, Paige Electric Co., LP, 559-431-2346).
 - 4. Workers engaged in the installation of irrigation pipe which is assembled using joint restraint fittings, shall carry on project site; a Certificate of Training from authorized

representative of Ductile Iron Fitting Manufacturer, (HARCO, Leemco, or approved equal) indicating:

- a. Contractor firm has been adequately trained in installation of joint restraints to replace thrust blocking.
 - b. Authorizing said worker to install Ductile Iron fittings, joint restraints, isolation line valves, manifold isolation valves.
5. Documents verifying Certified Irrigation Contractor, PVC Pipe Certification, Electrical Component Certification, and Joint Restraint Systems shall be provided to Consultant at least 30 days in advance of irrigation installation on project site.

1.6 SUBMITTALS

- A. Materials: At least thirty (30) days prior to ordering of materials, provide manufacturer catalog cut sheet and current printed specifications for each element or component of the irrigation system.
1. Submittals shall be in electronic format, on DVD or CD, as Adobe PDF documents.
 2. Provide three copies of submittals to Consultant. No material shall be ordered, delivered or work preceded in the field until the required submittals have been reviewed in its entirety and stamped approved.
 3. Delivered material shall match the approved samples.
 4. Substitutions: Use only materials and equipment that matches existing materials and equipment that are being replaced. No substitutions of materials will be approved on the sprinkler irrigation system!
- B. Operation and Maintenance Manual: At least thirty (30) days prior to final inspection, provide Operation and Maintenance manual to Consultant, in Adobe PDF format, containing:
1. Manufacturer catalog cut sheet and current printed specifications for each element or component of the irrigation system.
 2. Parts list for each operating element of the system.
 3. Manufacturer printed literature on operation and maintenance of operating elements of the system.
 4. Section listing instructions for overall system operation and maintenance. Include directions for Spring Start-up and Winterization.
- C. Owner's instruction: After system is installed, inspected and approved, instruct Owner in complete operation and maintenance procedures. Coordinate instruction with references to previously submitted Operation and Maintenance Manual.
1. Provide adequate notice to Owner for scheduling.
- D. Materials to be furnished: The following items shall be supplied as part of this contract and shall be turned over to Owner at Final Inspection.
1. Two (2) special tools / wrenches for disassembly and adjustment of each type of irrigation equipment/heads installed that require such special tools/wrenches.
 2. Two keys for each type of automatic controller.
 3. One valve box cover key.
 4. Documentation of Water Department's inspection and acceptance of backflow device and flow sensor.

E. Project Record Copy:

1. Maintain at project site one copy of project documents clearly marked "Project Record Copy". Mark deviation in material installation on Construction drawings. Maintain and update drawing at least weekly. Project Record Copy to be available to Consultant on demand.
2. Completed Project As-built Drawings:
 - a. Prior to final inspection, prepare and submit to Consultant accurate as-built drawings.
 - b. Show detail and dimension changes made during installation. Show significant details and dimensions that were not shown in original Contract Documents.
 - c. Field dimension locations of sleeving, points of connection, main line piping, wiring runs not contained in main line pipe trenches, valves and valve boxes, quick coupler valves, color of hot and spare wires – splice boxes, and the size of underground piping, valves, and drains.
 - 1) Dimensions are to be taken from permanent constructed surfaces, features or finished edges located at or above finished grade.
3. Provide a GPS coordinate location for each of the following items: point of connection, water meter, backflow device, isolation valves, control valves, gate valves, filters, quick coupling valves, controller, flow meters, manual drain valves, and other pertinent component of the irrigation system. Provide coordinates on as built drawings and recorded on a CD in WR format.

F. Controller map: Upon completion of system, place in each controller, a color-coded copy of the area that controller services; indicating zone number, type of plant material and location on project that zone services. Laminate map with heat shrink clear plastic.

1.7 INSPECTIONS

A. Inspections will be required for:

1. Hydrostatic test of irrigation main line.
2. Continuity test of spare wires from controller to last valve with Consultant.
3. Piping system layout before backfilling.
4. Mechanical joints and joint restraints before backfilling.
5. Coverage test.
6. Final inspection / Start of Maintenance.
7. Final inspection.

B. Inspection Requests: Notify the Consultant a minimum of 48 hours (two working days) in advance for inspections.

C. Closing in Uninspected Work: No work of this section shall be covered up or enclosed until it has been inspected and tested as required, and the work approved by Consultant.

1.8 WORKMANSHIP AND MATERIALS

A. It is the intent of this specification that material specified and shown on the construction documents shall be of the highest quality available and meeting the requirements specified.

- B. Work shall be performed in accordance with the best standards of practice relating to the trade.

1.9 DELIVERY – STORAGE - HANDLING

- A. During delivery, installation and storage of materials for Project, materials shall be protected from contamination, damage, vandalism and prolonged exposure to sunlight. Material stored at Project site shall be neatly organized in a compact arrangement and storage shall not disrupt Owner or other trades on Project site. Material to be installed shall be handled with care to avoid breakage or damage. Damaged materials shall be replaced with new at Contractor's expense.

1.10 GUARANTEE/WARRANTY

- A. Obtain in the Owner's name the standard written manufacturer's guarantee of materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. Guarantees shall be in addition to, and not in lieu of, other liabilities that the Contractor may have by law.
- B. Provide one-year warranty. Warranty shall cover materials, workmanship and labor. Warranty shall include filling and or repairing depressions or replacing turf or other plantings due to settlement of irrigation trenches or irrigation system elements. Valve boxes, sprinklers or other components settled from original finish grade shall be restored to proper grade. Irrigation system shall have been adjusted to provide proper, adequate coverage of irrigated areas.

1.11 MAINTENANCE

- A. Provide the following services:
 - 1. Winterize entire irrigation system installed under this contract.
 - 2. Winterize by 'blow-out' method using compressed air. Compressor shall be capable of minimum of 175 CFM. This operation shall occur at the end of first growing season after need for plant irrigation but prior to freezing. Compressor shall be capable of evacuating system of water from main line pipe and lateral line pipe.
 - a. Retrofit compressor with adjustable pressure regulation device. Compressor shall be regulated to not more than 60 PSI.
 - 3. Start-up system the following spring after danger of freezing has passed. Train Owner's Representative in proper start-up and winterization procedure.
 - 4. Check coverage and adjust as necessary.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Discrepancies between existing site conditions and those indicated on the plans shall be called to the attention of the Consultant prior to continuance of the project.
- B. If there is an existing sprinkler irrigation system on the site, remove lines being abandoned, and cap or plug the ends of lines remaining in service with proper fittings and joint restraint systems.

Remove or relocate existing heads and/or connect new lines to existing lines, as indicated on the plans. Existing heads or other hardware so removed, which are not to be relocated, will be returned directly to the Owner.

- C. Existing head, valve, valve marker, valve box, or other existing equipment located where there will be a grade or surface material change, shall be adjusted up or down to its proper position in relation to the new finished grade, at no additional cost to the owner, unless the plans show it to be relocated.

2.2 PIPE AND FITTINGS

- A. General: Polyvinyl Chloride Schedule 40 Pipe and Fittings. This specification covers requirements for Schedule 40 PVC pipe and fittings made from Type 1 Polyvinyl Chloride.
 - 1. Materials: Pipe and fittings shall be manufactured from a PVC compound which meets the requirements of Type 1, Grade 1 Polyvinyl Chloride, as outlined in ASTM D-1684. A Type 1, Grade 1 compound is characterized as having the highest requirements for mechanical properties and chemical resistance.
 - a. PVC Type 1, Grade 1 pipe compound shall have a 2000 P.S.I. design stress at 74 degrees F., which is listed by the Plastic Pipe Institute (PPI). Materials, from which pipe and fittings are manufactured, shall have been tested and approved for conveying potable water by the National Sanitation Foundation Testing Laboratory (NSF).
- B. Pipe: Pipe used on the project for the sprinkler irrigation system shall conform to the requirements of ASTM D-1685. DWV PVC pipe shall not be allowed.
 - 1. Pipe, 3 inches diameter and smaller, shall be schedule 40 PVC.
 - 2. Pipe, 4 inches diameter and larger shall be PVC Class 200 0-ring pipe.
 - 3. 3-inch and larger pipe shall have gasketed ductile iron, HARCO, Leemco or approved equal (**hereafter referred to only as Ductile Iron**) type fittings with transition gaskets if needed, at changes of direction tees, ells, caps, etc.
 - 4. Ductile Iron type fittings may have bolted end flanges and be wrapped in plastic. Bolts and nuts to be greased prior to assembly. Contractor exercising this option shall submit for approval to deviate from shown plan details.
 - 5. No bends other than very gradual in pipe shall be permitted. Use Ductile Iron elbow fittings of 90 and 45 degrees as the situations demand.
- C. Fittings:
 - 1. Fittings: Fittings used on the project for the sprinkler irrigation system shall conform to the requirements of ASTM D-2466.
 - a. Solvent weld fittings on PVC lateral lines shall be schedule 40.
 - b. Solvent weld fittings on PVC main lines shall be schedule 80.
 - c. Ductile Iron tees with swivel type connections and integral fitting angle valves shall be used for transition from mainline pipe to manifold construction.
 - d. Ductile Iron fittings shall include Joint Restraints at each fitting.
 - e. Ductile Iron fittings shall come from a manufacturer offering a 10-year warranty on products and replacement labor costs. Prior to install, provide Consultant documentation from the manufacturer shall provide documentation stating the above warranty information, including the labor reimbursement hourly rate.

- f. Ductile iron fittings and joint restraints shall have a fusion bonded epoxy coating on interior and exterior of the product surface, average of 10-12mm thickness. Epoxy coating shall conform to the requirements of CSA Z245.20-20 and NSF 61 for water services. Tar/bitumen coating will not be approved.
- g. Bolts used in fittings to be stainless steel.

D. Sleeves:

- 1. Sleeves shall be installed for irrigation pipe and wire under non-soil areas and where noted on the Drawings.
- 2. Minimum cover over sleeves shall be 18 inches except as noted otherwise.
- 3. Sleeve sizes shall be at least twice the nominal size of the pipe and wires, and a minimum of 4 inches.
- 4. Wires shall be sleeved separately within their own sleeve.
- 5. Sleeves shall be PVC Schedule 40 pipe.

2.3 VALVES AND VALVE BOXES

A. Valves:

- 1. Provide adequate material for the connection of valves to the system, i.e., adapters, flanges, nuts, bolts, gaskets, etc.
- 2. Main line or Isolation Gate Valves: Shall be Gate Valves.
 - a. Mainline valves shall be resilient wedge and conform to AWWA C153 standards.
 - b. Material shall be ductile iron per ASTM A-536, Grade 65-45-12. Epoxy coating on interior and exterior surfaces shall be fusion bonded epoxy, 12-14 mil thickness. The epoxy coating shall pass 90-Day immersion tests per CSA Z245.20-98. Tar/bitumen coating will not be approved.
 - c. Gate valves shall be available flange X flange models to mechanically connect to fittings or plastic pipe.
 - d. Gate valves shall have flange X push-on adapters with joint restraints, to connect to piping.
 - e. Valve bell end shall be deep bell, gasket and equipped with cast joint restraint clamps to securely fasten to plastic pipe. Restraints shall have blunt cast serrations. Machined threaded restraints will not be allowed.
 - f. Valves shall have a shroud around the 2" operating nut to accept IPS PVC sleeve which provides dirt-free access to actuate the valve.
 - g. Mainline valves shall be manufactured by Leemco or approved equal.
 - h. Mainline isolation gate valves shall be of the same manufacturer and shall provide a 10-year warranty on products and replacement labor costs. Prior to install, provide Consultant documentation from the manufacturer shall provide documentation stating the above warranty information, including the labor reimbursement hourly rate.
- 3. Manifold or RCV Isolation Valves: Shall be angle type.
 - a. Shall be epoxy coated cast iron.
 - b. Shall be same size as the largest lateral pipe they supply.
 - c. Shall connect to the main line pipe via a Ductile Iron Lateral Tee.
 - d. Lateral to mainline connection shall be made with ductile iron, resilient seated angle valve.
 - e. Valve body and restraint clamps shall be constructed of ductile iron per ASTM A-536, Grade 65-45-12.

- f. Epoxy coating on interior and exterior surfaces shall be fusion bonded epoxy, 10-12 mil thickness.
 - g. Valve mechanism and hardware shall be made of 100% 304 stainless steel. The valve stem shall be fine threaded stainless steel, O-Ring sealed for ease of operation.
 - h. Valve connection to the mainline fitting shall be spigot x bell, mechanically attached and swivel about the base 360 degrees to allow positioning of valve outlet to desired direction.
 - i. Valve outlet shall be deep bell, gasket and equipped with integrally cast joint restraint clamps to securely fasten pipe to the valve. Restraint shall have blunt cast serrations. Machined threaded restraints will not be allowed.
 - j. Swivel style extensions shall be stackable.
 - k. Valve shall have a shroud around the valve stem to accept IPS PVC sleeve.
 - l. Lateral to mainline transitions shall be as manufactured by Leemco or approved equal.
4. Quick Coupler Valves: Quick coupler valves shall be installed where specified on the plans. Each valve shall be heavy duty brass, two-piece, single lug locking cap. Each valve shall also be teed off the supply line with at least 24 inches of galvanized iron pipe and fittings from that point up shall be galvanized iron. A heavy-duty ball manual valve shall be installed upstream from each quick coupler or group of quick couplers on one supply line for water shut-off and maintenance.
- a. Quick coupler valves shall be installed within a 10" round bolt-down box with tee lid unless next to concrete pad, then install to grade.
 - b. Provide to the Owner at least 1 cap lock key and 1 quick-coupler key with a swivel hose bib attached. These keys shall be delivered prior to final acceptance of the project.
5. Control Valves: Control valves shall be installed as specified by the plans. Each valve shall be plastic globe diaphragm and electrically activated as specified on the plans. No valve shall be installed more than 12 inches below finished grade. Pipe on the control valve manifolds shall be Schedule 80 PVC pipe.
6. Manual Drain Valves: Manual drain valves shall be required at low points in the main lines. See plans, notes, and details.
- a. Manual drains shall be heavy-duty brass, ball valves.
 - b. The location of each manual drain shall be shown on the "as built" drawing with dimensions from the nearest permanent fixture, such as a building corner, etc.
7. Automatic Drain Valves: Automatic drain valves shall not be allowed on this project.
- B. Valve Boxes:
- 1. Main line buried gate valves shall be fitted with a 6" minimum diameter pipe sleeve and 10" round valve box, tee lid with stainless steel bolt. Install a quick coupler just downstream of each gate isolation valve, for blow out purposes.
 - 2. Control Valve Boxes: Control valves shall be housed in a standard or jumbo series heavy-duty plastic valve box, with a tee top, bolt-down lid, using stainless steel bolts.
- C. Valve Assembly Marking
- 1. Valve assembly and valve box must be permanently marked with the appropriate controller station number. Marking must be done in a manner which allows replacement of component parts without loss of marking.

2.4 BACKFLOW PREVENTION DEVICE

A. Assembly:

1. The reduced pressure zone assembly shall consist of two independently operating, spring loaded, "Y" pattern check valves and one hydraulically dependent differential relief valve.
2. The assembly shall automatically reduce the pressure in the "zone" between the check valves to at least 5psi lower than inlet pressure. Should the differential between the upstream and the zone of the unit drop to 2psi, the differential relief valve shall open and maintain the proper differential.

B. Materials:

1. Mainline valve body and caps including relief valve body and cover shall be Lead Free* cast copper silicon alloy.
2. Check valve moving member shall be center stem guided.
3. Hydraulic sensing passages shall be internally located within the mainline and relief valve bodies and relief valve cover.
4. Diaphragm to seat area ratio shall be 10:1 minimum.
5. Relief valve shall have a removable seat ring.
6. Check valve and relief valve components shall be constructed so they may be serviced without removing the valve body from the line.
7. Seat discs shall be reversible.
8. Shutoff valves and test cocks shall be full ported ball valves.

C. Rating:

1. The assembly shall be rated to 175psi (12.1 bar) working pressure and water temperature range from 32°F to 140°F (0°C - 60°C).
2. The Lead Free* Reduced Pressure Zone Assemblies shall comply with state codes and standards, where applicable, requiring reduced lead content.
3. The assembly shall meet the requirements of ASSE Standard 1013; AWWA Standard Code C511; CSA Standard B64.4; and approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.

2.5 IRRIGATION HEADS

A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

B. Plastic, Pop-up Spray Sprinklers:

1. Description:
 - a. Body Material: ABS.
 - b. Nozzle: ABS.
 - c. Retraction Spring: Stainless steel.
 - d. Internal Parts: Corrosion resistant.
 - e. Pattern: Fixed, with flow adjustment.
 - f. Flow: As indicated by model.
 - g. Pop-up Height: As indicated by model.
 - h. Arc: As indicated by model.
 - i. Radius: As indicated by model.

- j. Inlet: NPS 1/2 or NPS 3/4.

C. Plastic Shrub Sprinklers:

- 1. Description:
 - a. Body Material: ABS or other plastic.
 - b. Pattern: Fixed, with flow adjustment.
- 2. Capacities and Characteristics:
 - a. Flow: As indicated by model.
 - b. Arc: Full circle.
 - c. Radius: As indicated by model.
 - d. Inlet: NPS 1/2 or NPS 3/4.

2.6 ELECTRICAL MATERIALS

A. Conduit:

- 1. Conduits below grade shall be schedule 40 PVC of sufficient size to carry proposed wiring.
- 2. Conduit above grade shall be galvanized steel.
- 3. Low voltage (24 V) wiring shall be provided with a separate conduit/sleeve from both high voltage wiring (110/120 volt and higher) and the irrigation mainline sleeve.

B. Control Wires: Conventional irrigation control wire shall bear approval as UF/UL PE type of underground feeder and each conductor shall be of electrical conductivity grade copper in accordance with ASTM-30.

- 1. Control wire shall be specifically designed for direct burial use.
- 2. Sizes shall be #14 Paige PE RCV control wire or approved equal for conventional controllers.
- 3. Sizes shall be #14 gauge Paige Maxi wire or approved equal for decoder wire.
- 4. A minimum loop of 24 inches shall be left at each valve, at each splice, and at each controller for expansion and/or servicing of the wire.
- 5. Splices shall be water-tight, as specified above.
- 6. Wire, crossing water, attached to bridges, going under paving, or where conditions require protection, shall be housed in conduit or sleeves, out of ground conduits shall be metal rigid conduit. Buried conduit can be gray PVC conduit. (See next line item)
- 7. Decoder wire shall be encased in 1" HDPE poly irrigation pipe, 100 PSI, SDR 15, ASTM D2239/PE 3408, Centennial Cenflo or approved equal.
- 8. HDPE pipe ends shall terminate within the controller, a valve box, or a pull box. Pull boxes shall be 'Standard' size valve boxes, gray in color, and shall not exceed 300' in distance. 'SP' shall be branded on the box lid.
- 9. Multiple wires in the same trenches shall be banded together at 10-foot intervals for protection. Where wires pass under paved areas, Schedule 40 PVC sleeves shall be installed prior to installation of the paving, if possible, and prior to installation of the wires. Sleeves shall be sized as follows: 1-11 wires in 1-1/4 inch pipe; 12-15 wires in 1-1/2 inch pipe; etc.
- 10. Common or ground wires shall be white. The pigment or color of the wires shall be integrated into the covering, rather than painted on. No aluminum wire is to be used.

11. Control wire from controller to the master valve shall be Paige Maxi Wire or approved equal. Control wire from the controller to the flow meter shall be Paige PE39 or approved equal.

2.7 CONTROLLERS

A. Automatic Controllers:

1. A valve controller of the type specified on the plans shall be mounted at eye level on the wall of the structure designated on the plans or if no structure, the controllers are to be mounted inside a stainless steel strong box, in field applications with the necessary equipment needed to provide a complete system and operable control.
2. Interior Control Enclosures: NEMA 250, Type 12, dripproof, with locking cover and two matching keys.
 - a. Body Material: Molded plastic.
 - b. Mounting: Surface type for wall.
3. Control Transformer: 24-V secondary, with primary fuse.
4. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.
 - a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
 - b. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.
 - c. Surge Protection: Metal-oxide-varistor type on each station and primary power.

PART 3 - EXECUTION

3.1 GENERAL

A. Irrigation System Design and Water Supply

1. The sprinkler irrigation system is designed for the pressure indicated on the Drawings and is schematic only, with the intent to convey full coverage of the lawn and planting areas affected. The system must also provide the manufacturer's recommended minimum operating pressure or greater to every head while maintaining sufficient pressure to overcome the losses due to friction in the piping, fittings, and other equipment.
2. Adequate Water Supply:
 - a. Perform static pressure test prior to commencement of work.
 - b. Verify that proper connection is available and is of adequate size. Verify that culinary connection components may be installed as necessary. Notify Consultant in writing of problems encountered prior to proceeding.

B. Electrical Service

1. Make power connections indicated on the Drawings at interior installation location indicated.

C. Construction Staking

1. Provide the necessary staking to obtain the layout shown on the plans. The points of reference shall be the existing walks, buildings, curbs, etc. The staking shall be approved by the Consultant prior to commencing installation operations. Changes in the system which appear necessary, due to field conditions, must be called to the attention of the Consultant and approved at the time.

D. Perform site survey, research utility records, contact utility location services. Become familiar with hazards and utilities prior to work commencement. Install sleeving prior to installation of concrete, paving or other permanent site elements. Irrigation system Point of Connection components, backflow prevention, and pressure regulation devices shall be installed and operational prior to downstream components.

1. Main lines shall be thoroughly flushed of debris prior to installation of Remote Control Valves. Lateral lines shall be thoroughly flushed of debris prior to installation of sprinkler heads.
2. Be required to submit detailed Construction Schedule to Owner prior to commencement. Schedule shall be updated weekly.

E. Schedule and organize work to minimize impact on project usage during public hours. Confine work efforts to areas or zones which he can reasonably fence or protect, rather than spreading out trenching or other tasks across large areas of the site.

1. Schedule work to reduce or eliminate open trenches at the end of each work day.

F. Supply water to existing portions of the project during construction.

G. Maintain existing turf and plant material in healthy condition. Loss of turf or plant material due to neglect shall be replaced at no cost to Owner. Water to existing turf or plant material shall not be turned off for more than 48 consecutive hours.

3.2 EXISTING FIELD CONDITIONS

A. Preserve and protect existing trees, plants, structures, hardscape, and architectural elements from damage due to work in this section. In the event that damage does occur to landscaping or structures, the contractor will repair or replace damage.

B. Trenching or other work required in this section under limp spread of existing trees shall be done by hand or by other methods so as to prevent damage or harm to limbs, branches, and roots.

C. Trenching in areas where root diameter exceeds 2 inches shall be done by hand. Exposed roots of this size shall be heavily wrapped with moistened burlap to avoid scarring or excessive drying. Where trenching machine is operated in proximity to roots that are less than 2 inches, the wall of the trench shall be hand trimmed, making clean cuts through roots.

D. Trenches adjacent to or under existing trees shall be closed within 24 hours, and when this is not possible, the side of trench closest to tree or trees affected shall be covered with moistened burlap.

3.3 TRENCHING AND BACKFILLING

- A. Excavation and Trenching: Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
1. Excavation work shall be as deep and as wide as will be required to safely perform the work, such as making mainline connections or forming vaults.
 2. Trenches shall be deep and wide enough to provide working space for placing 2 inches of mortar sand bedding underneath new mainline pipe and fittings where the soil is rocky or gravelly.
 - a. 18 to 30 inches of cover shall be placed over the top of pipe and fittings on main lines (lines which maintain a constant water pressure).
 - b. Trench bottoms shall be sloped so that the pipes will gravity drain back to the main connection point or the nearest manual drain.
 - c. If the existing main line is deeper than 30 inches, install a riser to a depth of 18 to 30 inches and then install the new line at the required 18-30" depth. At no time will the mainline be installed deeper than 30" unless prior approval by Consultant.
 3. Trenches for lines supplying large rotors shall be deep enough to maintain a minimum of 8 to 16 inches of cover over the top of pipe and fittings. Trenches shall also be deep enough to guarantee that swing joints drain back to the lateral and supply lines. Lateral lines may be pulled by a mechanical puller provided minimum uniform depth and other applicable specifications are met.
 4. Trenches for lines supplying small heads shall be deep enough to maintain a minimum of 8 to 14 inches of cover over the top of pipe and fittings. Trenches for these lines shall be a minimum of 6 inches away from walks, curbs, and of sufficient width to accommodate tees coming out sideways (horizontally) from the laterals.
 5. Rocks or other debris over one inch in diameter uncovered during excavation or trenching shall be removed from the area.
 6. If more than one line is required in a single trench, that trench shall be deep and wide enough to allow for at least 6 inches of separation horizontally between pipes.
 7. Existing utility lines damaged during excavating or trenching shall be repaired immediately after notification of the utility owner and to his satisfaction. Should utility lines be encountered, which are not indicated on the plans, the Consultant shall be notified. The repair of damage shall be done as soon as possible by the Contractor or the utility owner, and proper compensation will be negotiated by the Owner. Such utility locations shall be noted on the "as built" drawings required before final payment of the sprinkler irrigation system contract.
- B. Backfill:
1. No backfilling of trenches shall be done until the system has been inspected for proper trench depths, installation of equipment, Ductile Iron fittings with joint restraints, control wire, and location of heads by the Consultant.
 2. Before trenches are backfilled, show the Consultant, the redlined "as built" drawing he has been keeping on the site, showing that changes and corresponding dimensions have been recorded where changes have been made.
 3. The system shall be tested under pressure for leaks, and general operation of the equipment. It must maintain a minimum pressure of 60 P.S.I. from the main connection to the farthest head. This may be tested and certified by the Consultant. Defects disclosed by the pressurization and operation test shall be corrected before proceeding with further work.
 4. Backfill under and around the lines to the center line of the pipe shall be placed in maximum layers of 6 inches and thoroughly compacted.

5. Special care shall be taken to assure complete compaction under the haunches of the pipe. Backfill compaction under the haunches of the pipe shall be compacted to the original density. Compaction requirements by mechanical compactor, i.e. jumping jack, above the pipe shall be the same as for surrounding areas.
6. No rocks larger than 1 inch in diameter, nor other debris, shall be backfilled into the trenches. Trenches shall be backfilled then saturated with water sufficiently to insure no settling of the surface after lawn is planted or sod is replaced.
7. Where trenching is done in established lawn, care will be taken to keep the trenches only as wide as is necessary to accomplish the work. The trenches shall be backfilled as specified above and then 4 inches of topsoil will be placed to bring the trench up to existing grade so that sod can be laid. The new sod shall be first grade sod per specifications of standard width and shall be laid along the trenches so as to match the existing sod. No small pieces of sod shall be used and only standard lengths shall be accepted. No sod from the construction site shall be used unless otherwise specified.

3.4 PIPE INSTALLATION

A. General:

1. Handling and unloading of pipe and fittings shall be in such a manner as to ensure delivery at the job site in a sound, undamaged condition. Pipe found to be damaged or defective in workmanship or materials shall be rejected or taken out if found installed.

B. Plastic Pipe:

1. Installation: The ends of threaded pipe shall be reamed and free of inside scale or burrs. Threads shall be cut clean and sharp, and to a length equal to 1-1/8 times the length of the female thread receiving the pipe. The threaded pipe shall be screwed into a full length of the female thread.

C. Fittings:

1. Tees coming out of main lines or valves and other fixtures, shall be horizontal so that no weight or pressure may be exerted through the fixture on the top or bottom of the main line.
2. Tees coming out of the lateral lines for heads and other fixtures shall be horizontal so that no direct weight or pressure may be exerted through the head to the top or bottom of the lateral line. Tees on lateral lines shall also be SxSxT to the head swing joints. See detailed drawings.
3. Pipe joints shall be properly sealed with pipe dope applied to and well worked over the areas to be joined. The dope for galvanized pipe shall be a white lead and pure linseed oil mixed to be a consistency of thick paint or it may be Teflon tape.
4. Every care shall be taken during installation to prevent dirt and debris (especially rocks) from getting into the pipes.

D. Joint Restraint System

1. Ductile iron pipe fittings and mainline gate valves shall be restrained by the joint restraint system. Fittings shall require a 'fitting to pipe restraint' and mainline gate valves shall require a 'valve to pipe' restraint. When required by manufacturer, gasket bell ends of pipe shall require a 'pipe to pipe' restraint.
2. Concrete thrust blocks shall not be used.
3. Joint restraints are needed on pipe sized 3" and larger, wherever the main pipe line:

- a. Changes direction at tees, angles, and crosses vertical and horizontal.
- b. Changes size at reducers.
- c. Stops at a dead-end.
- d. Valves at which thrust develops when closed.

E. Sleeves:

- 1. Verify sleeve locations below future hardscape. Flag existing sleeves and conduits installed by other trades.

3.5 BACKFLOW INSTALLATION

- A. Install backflow assemblies at locations shown on drawings, and in compliance with state and local codes and the applicable water district or State (whichever is most restrictive).
- B. Install a quick coupler just downstream of backflow device, for blow out purposes.
- C. Backflow devices shall have a protective enclosure.

3.6 FLOW SENSOR/MASTER VALVE

- A. Install Master Valve and Flow Sensor in high-density polymer concrete box (Old Castle Duo Mold or approved equal) sized as required to provide adequate clearance for service. Master valve and flow sensor shall be installed with unions both sides to allow for ease of maintenance and/or replacement.

3.7 VALVE AND VALVE BOX INSTALLATION

A. Valves:

- 1. Electric Control and Drip Control Valve Assembly:
 - a. Install valve assemblies as detailed on the plans.
 - b. Control valves shall be installed on a level crushed stone base. Grade of base shall be consistent throughout. Valves shall be set plumb with adjusting handle and bolts, screws and wiring accessible through the valve box opening.
 - c. Adjust zone valve operation after installation using flow control device on valve.
 - d. Do not install valves in areas where curbs and side walk come together or at intersection of two or more walkways.
 - e. Electronic control valves shall be installed with a Harco Ductile Iron IPS Lateral Isolation valve, which is installed upstream from electronic control valve.
 - f. No more than 2 control valves are to be downstream from a single lateral isolation valve.
- 2. Manual Drain Valves:
 - a. Manual drain valves shall be required at low points in the main lines. See plans, notes, and details.
 - b. Each manual drain valve will be accessed by a 2-inch PVC Schedule 40 pipe sleeve, capped by a locking valve cap with a key, enclosed within a 10" round down box top of drain sleeve to be 3" - 6" below lids.

- c. Each manual drain shall empty into a gravel sump, a minimum of 18 inches by 18 inches by 12 inches deep. The gravel shall be washed 3/4-inch rock. No pea gravel will be allowed.
- 3. Shut Off and Isolation Valves
 - a. Mainline Isolation Valves: Install mainline isolation valves as detailed in locations shown on the drawings. Main line buried gate valves shall be fitted with a 6" minimum diameter pipe sleeve and 10" round bolt down box. Install a quick coupler just down-stream of each gate isolation valve, for blow out purposes.
 - b. Ball Valves at Quick Couplers: shall be installed upstream from each quick coupler or group of quick couplers on one supply line for water shut-off and maintenance. Access ball valve with a 2" PVC sleeve-capped by a cap, within a 10" round box.
 - c. Isolation valves at valve manifold: Install Harco Ductile Iron IPS Lateral Isolation Valve on mainline as detailed on the upstream side control valves, no more than 2 control valves per 1 isolation valve.
- 4. Quick Coupler Valves
 - a. Quick coupler valves shall be installed where specified on the plans. Each valve shall also be teed off the supply line with at least 24 inches of galvanized iron pipe and fittings from that point up shall be galvanized iron. A heavy-duty ball manual valve shall be installed upstream from each quick coupler or group of quick couplers on one supply line for water shut-off and maintenance. Access ball valve with a 2" PVC sleeve-capped by a cap, within a 10" round box.
 - b. Quick coupler valves shall be installed within a 10" round bolt down box unless next to concrete pad, then install to grade.

B. VALVE BOXES:

- 1. Control Valve Boxes: No valve box shall rest directly upon the valve or fixture associated with it. Each valve box shall be centered on the valve it covers. Each valve box shall have 6 inches of clean 3/4" minus gravel placed in the bottom underneath the valve and lines to reduce the potential of mud and standing water therein.
 - a. Connections made inside the box to connect wires to the valve shall be made inside a watertight connector. Each connector shall be completely sealed and water proof with a minimum 24" wire loop in each box for each wire. Wires shall be twisted together first with pliers, soldered with lead free product, wire nut placed on soldered, twisted wire, then placed in waterproof tube. Wire nuts, tubes shall not be re-used or used more than once.
 - b. Splices in control wire shall also be housed in a valve box, as specified above.
 - c. Valve boxes shall have at least 4 bricks, one per corner, for support.

3.8 IRRIGATION HEAD INSTALLATION:

A. General:

- 1. Heads shall be installed above grade to minimize washing of the topsoil and seed during the landscaping establishment period, except those which border paving or flat work. These heads shall be installed at the finished grade of the adjacent paving or flat work. Prior to final acceptance of the project, heads shall be raised or lowered to final lawn or planting grade.
- 2. Heads installed in existing sod shall be set at the grade of the soil.

3. Rotary pop-up heads shall be installed at final grade on double swing joints. See detailed drawings in the section following this one. Swing joints must drain by gravity back to the supply lines.
4. Pop-up, shrub spray, lawn spray, bubbler and strip spray heads shall be installed as shown in the details.

B. Bubblers:

1. Install per schedule indicated on the Drawings.
2. Install Schedule 40 SXT tee on lateral pipe for transition to swing pipe. Each tree shall have one dedicated tee, with swing pipe branching off as shown on details to irrigate root ball. Install one dedicated tee per shrub or combine two shrubs per tee as shown on details. Do not install more than two shrub bubblers per tee.
3. Install bubbler lateral pipe such that swing pipe installation from lateral to plant material shall not exceed ten feet of tubing per run.

3.9 CONTROLLER INSTALLATION

A. Controller:

1. Install and supply a plugged outlet, junction box or separate breaker to furnish power to a new controller.
2. Surge protection shall also be provided at the incoming power and low voltage power side.
3. Grounding shall be per the national electrical code and the Grounding Grid detail shown on the plans.
4. Controller installations shall include commissioning, programming and training of staff.
5. Obtain inspection approval and shall have rejected installation repaired and re-inspected at no cost to the Owner.
6. Provide conduit, wiring, and materials along with the labor necessary to make the controller operational and in compliance with local electrical codes.
7. Confirm exact location and exterior sleeving routing for control wiring with Owner.

3.10 WIRING

A. Wire Placement

1. Each wire shall be tested for continuity prior to final acceptance of the project and guaranteed to be functional. Should the Owner maintenance personnel discover a defect within 1 year afterwards, locate the problem and cause it to be repaired at his cost.
2. Control wires shall be installed in trenches 6 inches to either side of or under the pipes so that the wire is protected from damage during backfilling and maintenance operations. See detailed drawing showing the wire located in those positions.
3. Control wires not placed in the trenches by the sides or under the pipes, shall be buried 18 inches or deeper and marked on the "as built" drawings.
4. Wires shall be installed with Warning Marker tape 6" above wire to indicate locations.

B. Tracer Wire

1. Tracer Wire shall be installed with irrigation mainlines.
2. Tracer Wire shall be (for Open-Trench Installation): direct burial #12 AWG Solid (0.0808" diameter), steel core soft drawn tracer wire, 250# average tensile break load, 30 mil high molecular-high density polyethylene jacket complying with ASTM-D-1248, 30 Conductive

Trace Wire for SID Standard Specifications Nonmetallic Pipe Installation volt rating. Color shall be "blue" for domestic water (potable) pipelines and "purple" for raw water (non-potable) pipelines. Manufactured by Copperhead Industries part number 1230-SF or approved equal.

3. Splices along the continuous run of trace wire for repair of a wire break or replacement of failed segment of wire shall use 3M Brand DBR Direct Bury Splice Kit or approved equal. Approved alternatives must securely connect two or more wires, effectively moisture seal by means of a dielectric non-hardening silicone sealant, manufacturer approved for direct burial and rated for a minimum of 50V.
4. Branch connections for laterals, turnouts, services and appurtenances shall use DryConn Direct Bury Lug Aqua or approved equal. Approved alternatives must securely connect one or two wires to the main trace wire without cutting the main trace wire, effectively moisture seal by means of a dielectric non-hardening silicone sealant, manufacturer approved for direct burial and rated for a minimum of 50V.

C. Communication Cable

1. Flow sensor communication cable from flow sensor from hydrometer to controller shall be Paige Electric PE-393 communication cable direct wired.
2. Master valve communication cable from master valve hydrometer to controller shall be 19-gauge 3 pair cable: (1) #14 AWG Red Control Wire with (1) #12 AWG White Common Ground direct wired.
3. Communication cable shall be connected to flow sensor and master valve according to manufacturer's recommendations. Communication cable shall be run from the flow sensor at the noted points of connection and run to controller.

3.11 FINISHING AND TESTING

- A. Ensure work is installed with care and best practices taken, to maximize the efficiency and uniformity of the system.
- B. Before pipes are covered, contact the Consultant 24-hours in advance to inspect the system for compliance with specifications and drawings. Required changes will be made at no expense to the owner.
- C. After piping, and valves are in place and connected, the pipes shall be flushed under a full head of water.
- D. When installation of equipment is complete and back filling, and grading operations are complete, call for an operational test and major inspection of the sprinkler irrigation system. Notice shall be given, in writing, 3 days in advance to the Consultant so that proper scheduling can be done for those who are to attend.
- E. At the appointed time, an inspection of valve boxes, controllers, gate valves, and heads shall be made. The entire system will be tested to check for pressure, operation, water coverage, and head adjustment. A list of discrepancies (punch list), shall be written within 3 days and distributed as needed. Each item on the list shall be corrected before the system will be approved by the Inspector who will notify the Consultant before payment will be made. The Contractor will be back charged for time spent by Owner and Consultants who have been brought to the site for a final inspection when the project is not ready for a final inspection.
- F. The Owner may hire a third-party IA approved CLIA contractor to perform a uniformity and efficiency audit on representative portions (or the entire area) of the turf zones within the project, at the discretion of the Owner.

- G. Provide one or more irrigation technicians onsite prior to the audit to perform fine tuning of zones, and during the audit to tune again zones just prior to being audited.
- H. Concerns the Contractor has with installing the system per plan, which will reduce uniformity and efficiency shall be brought to the Consultant's attention in writing immediately.
- I. Following the audit, call for an operational test and major inspection of the sprinkler irrigation system. Notice shall be given, in writing, 3 days in advance to the Project Manager so that proper scheduling can be done for those who are to attend.
- J. Prior to acceptance of Project by Owner, engage the controller manufacturer factory authorized service technician to commission, test, inspect, and certify the system is complete, and full operable and ready for use. Make corrections, changes, and repairs to the system at no cost to the Owner to the control system until it is in operable condition ready for acceptance and use.

3.12 CLEANING AND ADJUSTING

- A. At the completion of the work, parts of the installation shall be thoroughly cleaned. Equipment, pipe, valves and fittings shall be cleaned of grease, metal cuttings and sludge that may have accumulated by the operation of the system for testing.
- B. Upon completion of installation work, remove leftover materials, equipment and debris resulting from work of this section from the site in a safe and legal manner.
- C. Adjust valve boxes to grade as required.
- D. After completion of grading, planting, and mulching, carefully adjust irrigation heads for proper watering.
- E. Each control zone shall be operated for a minimum of 15 minutes and checked for consistency of delivering water. Valves, timing devices or other mechanical or electrical components, which fail to meet manufacture's standards, shall be rejected, replaced and tested until they meet the manufacturer's standards.

3.13 GUARANTEE AND MAINTENANCE

- A. Guarantee the workmanship, materials, fixtures, and equipment to be free from defects for one year after Substantial Completion has been granted.
- B. In the fall of the year during the installation and guarantee period, meet with the Owner maintenance personnel on the site. Winterize the system by draining of the water and doing everything necessary to insure protection of the system until spring. Blowing out the lines by compressor shall be permitted during the one year guarantee. The individuals involved from both parties shall exchange information necessary for the eventual take-over of the system by the Owner.
- C. Ensure and guarantee complete drainage of the system. In working with or connecting to an existing system, he shall guarantee compatibility in operation and drainage between the two systems.
- D. With the Owner maintenance personnel, inspector, or Consultant in attendance, energize the sprinkler irrigation system again the following Spring and shall repair defects found as a result of

Winter damage, improper installation, improper maintenance, defective materials or inadequate sprinkler drainage.

- E. Coordinate with the landscaping sub-contractor during the entire landscaping and lawn establishment period on the use, scheduling, and maintenance of the sprinkler system.

3.14 FINAL INSPECTION

- A. At the end of the guarantee period, when the lawn and landscaping have been approved, call for a final inspection of the sprinkler irrigation system. There shall be 5 days' notice given, in writing, to the Consultant, prior so that the appropriate people may attend.
- B. Prior to that time, heads shall have been adjusted to their proper pattern, radii, and height. The system shall have been flushed out, checked for operation, and defects corrected. The entire system will be inspected and checked to determine if everything is in working order to be turned over to the Owner. A final list of items found in need of correction, will be made and will be corrected.
 - 1. The Consultant will notify the Owner when they have verified that every item is acceptable.
 - 2. Upon final acceptance of the project by the Consultant, the Owner shall assume responsibility for the system.

END OF SECTION 32 8400

SECTION 32 9113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes planting soils specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 31 1000 "Site Clearing" for topsoil stripping and stockpiling.

1.2 DEFINITIONS

- A. Duff Layer: A surface layer of soil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Imported Soil: Soil that is transported to Project site for use.
- C. Planting Soil and Imported Planting Soil: Existing on-site soil or imported soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- D. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- E. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- F. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.
- C. Agronomic Analysis: Collect soil and have the sample analyzed by an analytical laboratory experienced in providing agronomic analyses.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. Planting-Soil: Existing, on-site surface soil, with the duff layer, if any, retained; modified to produce viable planting soil. Blend existing, on-site surface soil with soil amendments and fertilizers per an agronomic analysis. For bidding purposes anticipate approximately, the following quantities to produce planting soil, which will be revised per the agronomic report:
 - 1. Weight of Nitrogen: 0.7 pounds per 1000 sq. ft. per 6 inches of soil depth.
 - 2. Weight of Phosphorus: 1.0 pounds per 1000 sq. ft. per 6 inches of soil depth.
 - 3. Weight of Potassium: 1.0 pounds per 1000 sq. ft. per 6 inches of soil depth.
- B. Imported Planting-Soil: Imported, naturally formed soil from off-site sources and consisting of sandy loam or loamy sand soil according to USDA textures; and modified to produce viable planting soil.
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.
 - 2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 7.0 to 7.8 and minimum of 2 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 - 3. Unacceptable Properties: Clean soil of the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
- C. Amended Soil Composition: Blend imported, unamended soil with soil amendments and fertilizers per an agronomic analysis. For bidding purposes anticipate approximately, the following quantities to produce planting soil, which will be revised per the agronomic report:
 - 1. Weight of Nitrogen: 0.7 pounds per 1000 sq. ft. per 6 inches of soil depth.
 - 2. Weight of Phosphorus: 1.0 pounds per 1000 sq. ft. per 6 inches of soil depth.
 - 3. Weight of Potassium: 1.0 pounds per 1000 sq. ft. per 6 inches of soil depth.

2.2 INORGANIC SOIL AMENDMENTS

- A. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- B. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- C. Perlite: Horticultural perlite, soil amendment grade.
- D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
 - 1. Compost material shall be dark brown in color with the parent material composted and no longer visible. The structure shall be a mixture of fine and medium size particles and humus crumbs. The odor shall be that of rich humus with no ammonia or anaerobic odors.
 - 2. Bulk compost shall have the properties as shown below:
 - a. Feedstock: May not include sewage sludge nor animal waste.
 - b. Reaction: pH of 6.5 to 8.5.
 - c. Cation exchange capacity (CEC): Greater than 45 meq/100 grams.
 - d. Carbon: Nitrogen (C:N) Ratio: Less than 20:1
 - e. Organic Matter Content: Greater than 30%.
 - f. Total Nitrogen (not added): Greater than 1%.
 - g. Maturity Index: Greater than 50% on Maturity Index at a 10:1 ratio.
 - h. Stability Indicator, CO₂ Evolution: Biological Available C (BAC):
 - 1) Less than 4mg/CO₂-C/g OM/day is desirable.
 - 2) From 4mg through 8mg CO₂-C/g OM/day is acceptable.
 - 3) Greater than 8mg CO₂-C/g OM/day is not acceptable.
 - i. Particle Size: Minimum of 98 percent passing through a 2-inch sieve.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. 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 testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- B. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- C. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

- C. Mixing: Spread unamended soil to total depth of 8 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
 - a. Mix sulfur with dry soil before mixing fertilizer.
 - b. Mix fertilizer with planting soil no more than seven days before planting.
 - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests:
 - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.
 - 2. Agronomy: Test existing, on-site surface soil and imported soil for recommendations for amendments and fertilizers required to develop planting soils.
- C. Soil will be considered defective if it does not pass tests.
- D. Prepare test reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.5 PROTECTION AND CLEANING

- A. Protection Zone: Identify protection zones according to Section 01 5639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.

4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
- C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

END OF SECTION 32 9113

SECTION 32 9200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sodding.
- B. Related Requirements:
 - 1. Section 32 9113 "Soil Preparation" for preparation of planting soils.

1.2 DEFINITIONS

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.

1.3 PREINSTALLATION MEETINGS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed.
 - 1. Certification of each seed mixture for turfgrass sod.
- B. Product certificates.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 2. Pesticide Applicator: State licensed, commercial.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species indicated on the Drawings.

2.2 FERTILIZERS

- 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: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.3 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Reduce elevation of planting soil to allow for soil thickness of sod.

- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Consultant's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across slopes exceeding 1:3.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.3 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

3.4 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Consultant:
 - 1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION 32 9200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plants.
 - 2. Tree-watering devices.
 - 3. Landscape edgings.
- B. Related Requirements:
 - 1. Section 32 8400 "Planting Irrigation" for coordination of watering devices to plant locations.
 - 2. Section 32 9113 "Soil Preparation" for preparation of planting soils.

1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- C. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.
- D. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples of each type of mulch.

1.5 INFORMATIONAL SUBMITTALS

- A. Product certificates.

- B. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.7 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 1. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- B. Handle planting stock by root ball.
- C. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.9 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 - 1. Size: 5-gram tablets.
 - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

- A. Organic Mulch: Ground or shredded bark or wood and bark chips as indicated on the Drawings.

2.4 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

2.5 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.6 TREE-WATERING DEVICES

- A. Watering Device: Standard product manufactured for deep irrigation of plants; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.
- C. Before planting, obtain Consultant's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
 - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 2. Excavate approximately three times as wide as ball diameter.
 - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

3.3 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
 - 1. Backfill: Planting soil. For trees, use excavated soil with agronomic recommendations for amendments for backfill.
 - 2. Balled and Burlapped Stock: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: Two per plant minimum with three for each caliper inch of plant.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.4 TREE, SHRUB, AND VINE PRUNING

- A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Consultant, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- B. Do not apply pruning paint to wounds.

3.5 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil with agronomic recommendations for amendments for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.6 PLANTING AREA MULCHING

- A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 12 inches and secure seams with galvanized pins.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
 1. Trees in Turf Areas: Apply organic mulch ring of 2-inch average thickness, with radius or area indicated on the Drawings around trunks or stems. Do not place mulch within 6 inches of trunks or stems.
 2. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.7 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide the quantity of devices indicated on the Drawings for each tree.

3.8 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- D. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- F. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.9 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period for Trees and Shrubs: Six months from date of Substantial Completion.
 - 2. Maintenance Period for Ground Cover and Other Plants: Six months from date of Substantial Completion.

END OF SECTION 32 9300

SECTION 32 9443 – TREE GRATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Tree grate and installation frames.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 25 years tree grate manufacturing experience.
 - 1. Castings will be squared and flat, free of burrs, slag, air pockets, blow holes, flashing and grinding or welding on exposed surfaces. Excessive warping or shrinkage is not acceptable.
 - 2. All visible welds on installation frames to be ground smooth. Frames will be true to specified diameter.
- B. Installer qualifications: 2 years minimum experience installing tree grates and support frames.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Inspect material immediately upon delivery, noting on delivery receipt all damage and/or discrepancy between delivered material and packing slip
- B. Store product in manufacturer's packaging until ready to install.

1.4 WARRANTY

- A. Tree grates and frames shall be warranted by the Manufacture against defects in materials and workmanship for a minimum of one (1) years.

PART 2 - PRODUCTS

2.1 TREE GRATES

- A. Basis-of-design product: Provide tree grates based on the product named:
 - 1. Ironsmith Pave-Grate suspended paver system cantilevering tree grate system.
- B. Tree Grate and Frame:
 - 1. Materials:

- a. Tree Grate material shall be high quality, 100% recycled, cast aluminum with 100% recycled content per ASTM B26.
 - b. Finish on Tree Grates shall be natural raw unfinished.
 - c. Tree Grate Frames shall be per Drawings and manufacturer for embedded installation into new concrete surround.
 - 1) Tree grate frame material shall be structural aluminum and other shapes as necessary, per ASTM B221.
 - 2) Finish on tree grate frames shall be natural raw unfinished.
- 2. Load Rating:
 - a. Pedestrian.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until site is properly prepared.
- B. If substrate preparation is the responsibility of another trade, please coordinate with and notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPERATION

- A. Clean surfaces thoroughly prior to installation
- B. Prepare surface as needed to perform installation per manufacturer's recommendation.

3.3 INSTALLATION

- A. Install tree grates in relation to adjacent paving surface with uniformity of appearance, in locations as indicated on plans.
- B. Install tree grate frames by incorporating them into the tree pit forming material, taking care to ensure that the frame is on a FLAT PLANE, and sufficient bracing is in place to prevent frame deformation during concrete pouring and curing.
- C. Clean concrete debris from tree grate frame.
- D. Install tree grate, grinding leveling pads and shimming as needed to hold tree grates level and prevent rocking. Gap between grate and frame in finished installation shall not exceed 1/8" on all sides.

END OF SECTION 32 9443